AGRICULTURAL ENGINEERING

JULY • 1949

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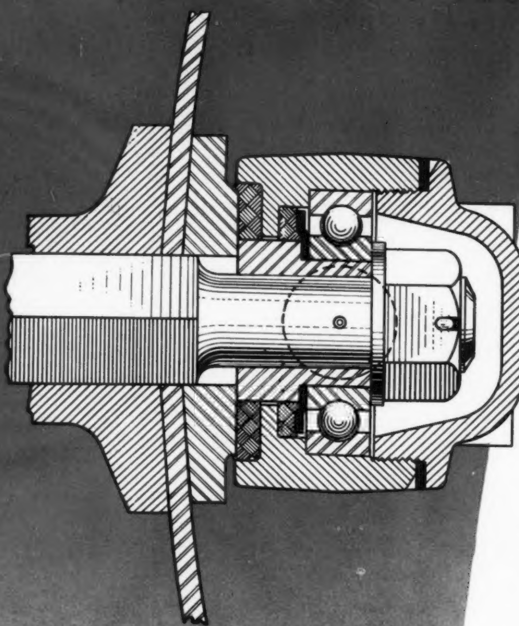

● For a real problem in applied mechanics, just try to analyze the forces tending to cause and to resist rotation of a disk harrow blade, and to arrive at its resultant rates of rotation, at various angles and depths of operation. You may be surprised, at the greater angles and depths, to learn how little the rotational forces exceed the retarding forces.

As the net rotational moment approaches zero, the part played by bearing friction becomes critical. It not only determines the point at which rotation ceases, but affects the amount of slippage while still turning. Slippage, in turn, affects the ability to cut and cover trash, and to attain tilth.

Bearing friction in the Case "CO" offset harrow is greatly reduced by deep-groove annular ball bearings. They are so thoroughly sealed, both to retain lubricant and to exclude dirt, that they normally need no attention for the full life of the big, heat-treated steel blades. Being trunnion-mounted they are immune to frame deflection.

A BEARING that Boosts Yields

● Created primarily for heavy-duty grove tillage the "CO," by the quality of its performance, its care-free operation, and its capacity in relation to power requirement, is earning adoption also for open-field work. The way it closes automatically for right turns, its simple adjustments for even penetration, rear gang angle, and control of tracking, all have their parts in its performance.

In terms of timeliness and tilth, the "CO" promotes high yields per acre. This, plus savings in man-hours, helps to achieve the thing that counts in modern agriculture — high *yield per man*. J. I. CASE CO., Racine, Wis.

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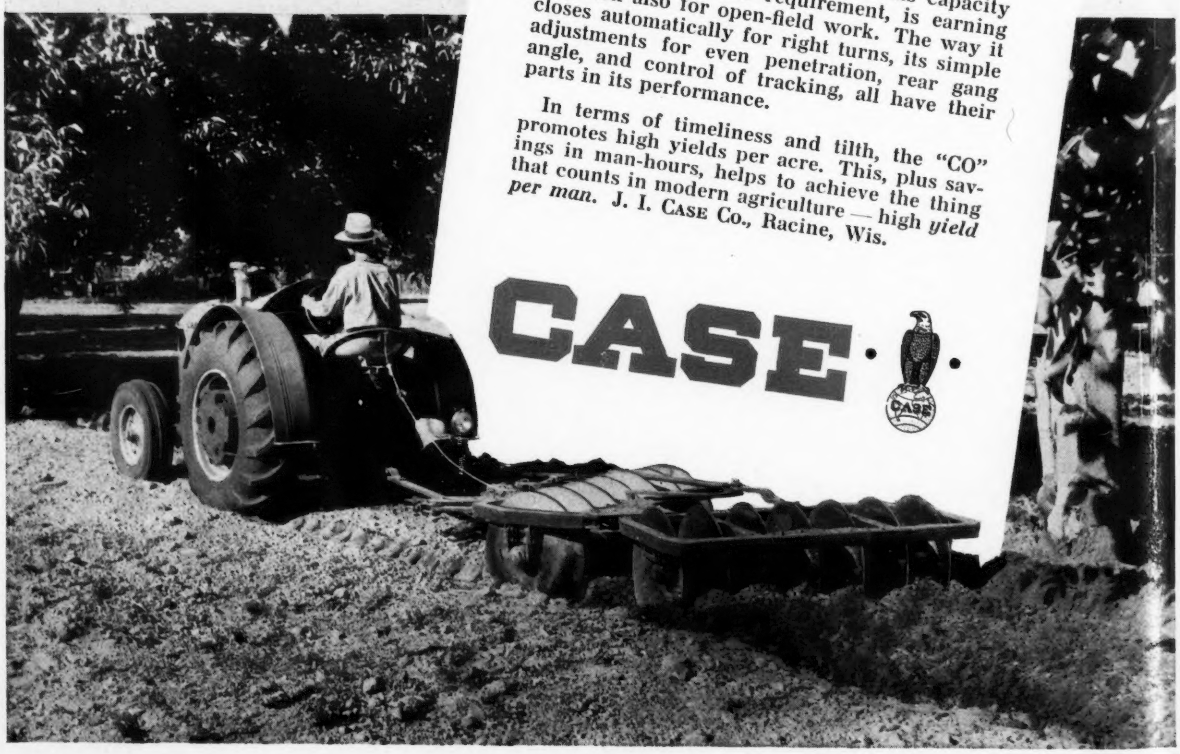

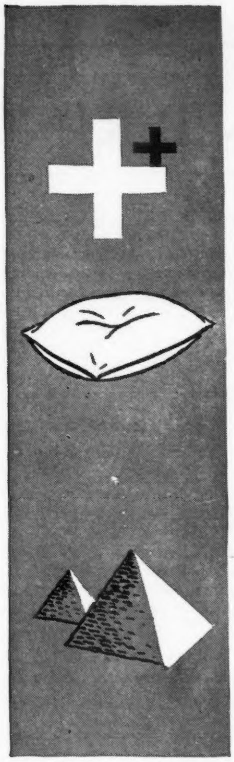

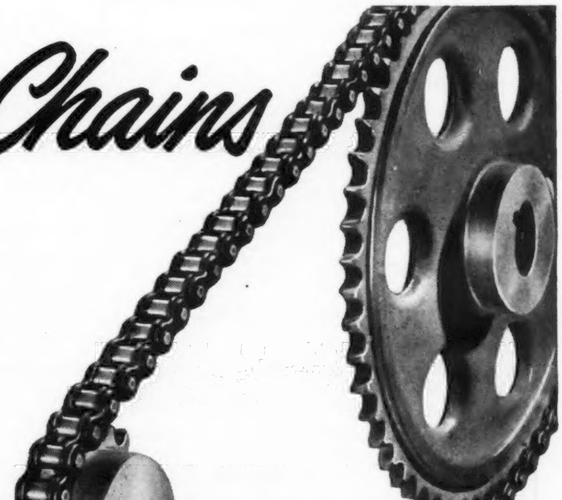

AGRICULTURAL ENGINEERING

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Vol. 30, No. 7

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INDEX TO ADVERTISERS

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EDITORIAL

Human "Motive" Power

IN ADDRESSING the recent annual meeting of the American Society of Agricultural Engineers on "The Engineer as a Citizen," Leonard J. Fletcher emphasized the point that it is human nature to think and act with essentially selfish motives.

It is not a function of engineering to deplore human motives as something less than ideal. It is a legitimate engineering function to work toward a better understanding of human "motive" power, as the directing human power which controls the application of other forms of power, and all engineering and other activity. This leads us to hazard some preliminary editorial observations on the subject:

One person's selfish motives may often be best satisfied by permitting, or helping, someone else to satisfy his selfish motives.

This basis for organization and teamwork has been one of the human race's most difficult lessons. Many of us learn it up to a certain point and still fail to see its full implications.

It is easy to understand when helping others offers us the immediate and direct return of a mutual back-scratching proposition. It is still beyond the comprehension of many people when the benefit to them is slightly indirect, delayed, or otherwise obscure, even if equally real.

It is easy for the neighborhood storekeeper to see that his prosperity will be directly influenced by that of the surrounding community. It seems considerably more difficult for the American workman to see that the amount and buying power of his pay check may be influenced by the security of capital invested in mines in China, or that he may be better off than would otherwise be possible, because the company he works for employs competent executives at ten to one hundred times his own pay.

Business leaders have been little if any more far-sighted in appreciating the value to them of having well-satisfied customers and employees. Guaranteed satisfaction to the customer, as a general practice even in the United States, is a comparatively recent development. It took them a long time to see that by a little better engineering of their products and production methods, and by giving their employees more pay and better working conditions, they could make more profits while offering better products to more customers at lower prices.

The day of capital and management helping the general public to understand their useful place in production is just beginning.

Many other ways in which we can best satisfy our own selfish motives by helping others in our complex economic and social organization may remain to be discovered by those most directly concerned.

Engineers, by reason of their training, experience, professional ethics, and high standing, may be best qualified to study and clarify some of the quantitative cause and effect relationships in an economy of highly specialized production, free enterprise, extensive exchange of goods and services, and wide distribution of the values produced.

The problem is complicated by the diversity of our selfish motives; by the fact that they may be sound and highly moral or the complete opposite; by competition for the control and use of limited resources; and by our limited understanding of cause and effect relationships in most human activities. But in many of its parts it is no more complicated or intangible than many problems which engineers have already solved. Space, time, numbers, diversity of function, and lack of personal acquaintance between all of the members change the details but not the principles of economic teamwork.

The "live and let live" principle of human relationships has suffered many setbacks because its value in the satisfaction of selfish motives was not fully appreciated. It has survived because its value is real. It is again under heavy attack because its value is not understood. It is important that its values be clarified if the human power of selfish motives is to produce continued progress rather than self-destruction.

Another Depression?

IT SEEMS that the question "When will we have another depression," is the basis of a currently popular guessing game. Individual viewpoints range all the way from the idea that depression is overdue and inevitable, through the theory that it is here now, to the school of thought which says it need never happen.

This appears to be a superficial approach to a more fundamental question of interest to engineers, namely, "How sound is our present economic setup?" A lot of both favorable and unfavorable factors are involved in any fair and reasonably thorough appraisal of the situation.

There is real cause for apprehension in such factors as the mortgaged prosperity of high government debt and high credit buying of consumer goods; reduced profit incentives for venture capital; growing population pressures and the continued squandering of exhaustible resources; the discouragement of legitimate private enterprise; reduced pioneering spirit, independence, and pride of workmanship; general lack of understanding of the nature, means, and importance of economic production; political tinkering with the economic system; the increased willingness of people to accept a dole, and the very existence of apprehension.

It is significant that engineering developments are among the more favorable factors contributing to continued high employment and prosperity.

Research is providing new ways of developing, conserving, and getting increased values from our natural resources.

New industries are creating new products, improved products, new markets, new employment, more efficient production equipment, and new values in consumer goods.

Engineering is showing the way to increased production per man-hour, per acre, and per dollar of investment; and to increased time and means with which more people can enjoy more consumer goods.

Engineering is further reducing the pressure of work necessary to produce a bare existence, and is enabling more people to become better educated than ever before.

The Hoover Report, in effect an engineering analysis pointing the way to more economical and satisfactory government, is being considered seriously by many people.

These are a few of the favorable factors. If another depression occurs, it will occur in spite of engineering rather than because of it.

Another strongly favorable influence will exist when a lot of people stop guessing when a depression will occur and start asking themselves, "How sound is our present economic system? What can we do to overcome or minimize its known weak spots, and further strengthen its strong points?"

Engineers generally seem to have some reasonable answers to offer, and can well afford to encourage these questions. Engineers have as big a stake in prosperity as anyone, and an obligation to help maintain it through understanding as well as by technical progress.

Southern Comfort

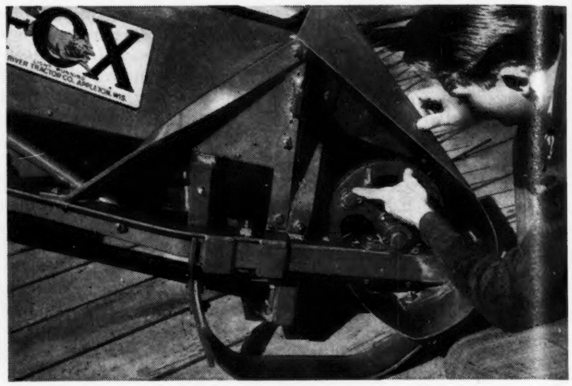
IT IS always refreshing to note appreciation of sound engineering and sound agriculture on the part of responsible business leaders. Recent refreshment of this flavor is found in recommendations by the National Planning Association's Committee of the South, as reported in "Time".

The Committee's recipe for southern comfort — "new capital investment of $4 to 5 billion annually 'from whatever source available.' "

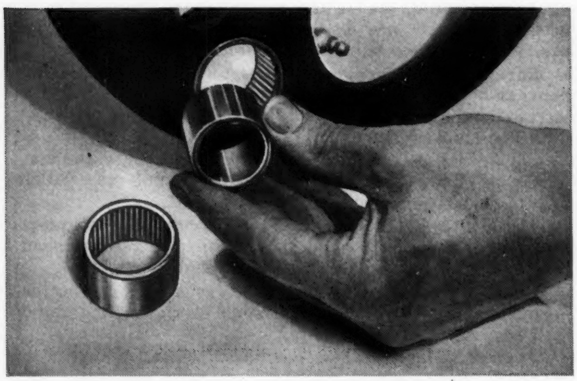
Further recommendations in the words of "Time": "Agricultural workers should move into factories and the number of 'uneconomically small farms' should be reduced. On the other hand, the number of medium-sized mechanized farms should be increased, and some of *(Continued on page 356)*

Torrington Needle Bearings simplify lubrication and maintenance in Fox Pick-Up Cutters

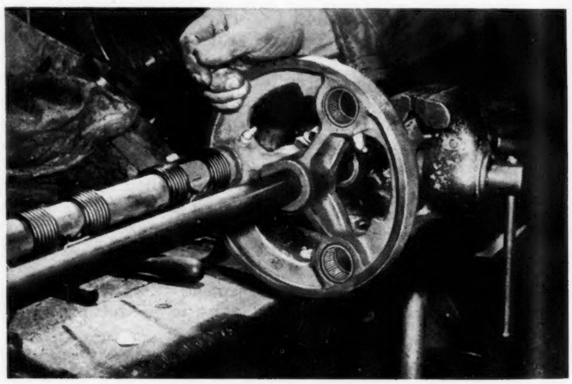
The Pick-Up Cutter made by Fox River Tractor Company, Appleton, Wisconsin, harvests all types of forage crops. It's fast—handling a ton of hay in 6 minutes—reliable, and easy to lubricate and maintain, thanks to such features as Torrington Needle Bearings.



Six Needle Bearings in the pick-up unit, for example, keep wear to a minimum and assure efficient use of lubricants. Needle Bearings are also used in the cutter-bar attachment, for harvesting standing crops, and 7 Needle Bearings are used in the Crop Blower.

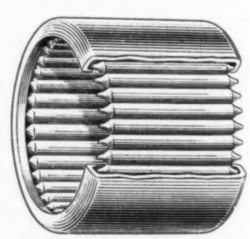


Lubricant is effectively retained by the turned-in lips of the Needle Bearing which ride close to the shaft, or in this case to the hardened and ground inner race. These close-fitting lips also help to keep out dust, moisture and chaff during pick-up operation.



This simple design for anti-friction efficiency brings many advantages. Installation of Needle Bearings is a quick, easy arbor press operation. Long service life is assured by the high capacity provided by a full complement of small diameter precision rollers.

Give your farm equipment the advantages of anti-friction operation with low unit and installation costs, by using Torrington Needle Bearings. Our engineers will be glad to give you a hand. Write us today. The Torrington Company, Torrington, Conn., or South Bend 21, Ind. District offices and distributors in principal cities of United States and Canada.



TORRINGTON *NEEDLE* BEARINGS

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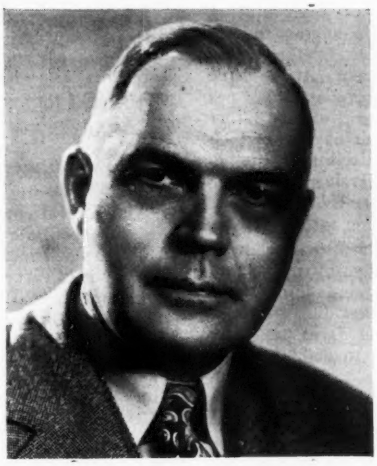
// AGRICULTURAL ENGINEERING

VOL. 30 JULY, 1949 No. 7

Agricultural Engineering — Past and Future

By Arthur J. Schwantes
FELLOW A.S.A.E.

THE history of American agriculture shows that tremendous changes have taken place during the last century and a half. The ox and the horse have been replaced by the farm tractor; the most primitive types of farm machinery have been replaced by efficient labor-saving machines such as the gang plow, combine, and corn picker; the candle and the oil lamp have been largely replaced by the electric light; the log cabin, with no conveniences, has given way to the modern farm home; advanced types of animal shelters are now used instead of the pole and straw sheds; and over 100,000,000 acres of wet and arid land have been brought to a high stage of productivity made possible by drainage and irrigation.



ARTHUR J. SCHWANTES
President, A.S.A.E., 1948-49

Innumerable factors have contributed to these and other changes. Agricultural engineering has been responsible for many, and many have been due to important contributions from other fields such as soils, agronomy, animal husbandry and entomology.

Soil and Water Control. The history of drainage and irrigation in the United States dates back to the early 1800's. Few of us realize that much of what is now referred to as the corn belt area was once wet land. As a result of a century of drainage, many areas previously worthless have been changed into some of the most productive lands. The productivity of about one-half of the grade I land (excellent rating) in the United States is dependent on good drainge. Much of it is now in drainage enterprises. When land of grades I and II are taken together, the productivity of one-third of the combined area is dependent on artificial drainage.

Irrigation in the United States, by the white man, dates back to the settlement of the arid west. Here some 20,000,000 acres of fertile dry land have been made productive. The last 20 years has witnessed an extension in irrigation from the west to the more humid areas. Today supplemental irrigation is practiced in most states with promising results.

The importance of improving and saving our fertile top soil has been neglected in the United States. During the past 30 years the agricultural engineer in cooperation with other agricultural scientists, has done much to stimulate research and practices which will better conserve our soil and water resources.

Farm dwellings and structures used for livestock shelters and feed storages have undergone many changes since the days of the simple building made of logs in the wooded areas and the sod or clay structures that were built on the prairies. Buildings represent a large percentage of the investment of the physical plant. The average of 68 dairy farms in southeast Minnesota shows that buildings represent about 25 per cent of total farm capital and 82 per cent of the value of land. On farms in southwest Minnesota where beef cattle and hogs are the principal source of income, buildings represent about 18 per cent of the total farm capital and about 52 per cent of the value of the land.

The demand for better quality farm products and for better working conditions has resulted in greatly improved buildings. Many dairy barns are now insulated and ventilated and have improved facilities for cleanliness. Modern insulation and heating have also been applied to farm dwellings.

Farm power and machinery have increased the productive efficiency of the agricultural worker because his activities have changed from that of producing the energy to do the work, to the direction of power. In 1870 there was available for the average worker in this country 1.6 horsepower. This had increased to 5.3 in 1920 and then to 27.8 in 1940, with an estimated 33.6 in 1948. The number of tractors on farms in the United States has practically doubled since 1940 and now approximates 3 million.

Electrical energy with its potentialities for saving labor about the farmstead and improving living conditions is now available on about two-thirds of the farms in the country. In 1925 the percentage was less than 5. Although standard electrical appliances such as the vacuum cleaner, range, and water heater are in use on many farms, the full use of electrical energy in labor saving and improved living has hardly begun.

Population shifts have occurred from farms to urban communities. In 1820 about 72 per cent of the workers in the United States were engaged in farming. At that time each farm worker produced enough food and fiber to support 4½ people. In 1945 one agricultural worker produced enough to support 15 people. In 1900 only about 38 per cent of the workers in the country were engaged in agriculture, and in 1940 only about 18 per cent were so engaged. World War II had an accelerating effect on the population shift away from the farm. In 1945 the farm population was 16.7 per cent less than it was in 1940. Some of this tremendous and sudden loss was regained however, for in 1948 this percentage is estimated to be about 10. Thus a large segment of our population has been released from the necessity of providing food for themselves so they might be engaged in the production of other commodities and services that contribute to new living standards.

AGRICULTURAL CHARACTERISTICS OF ENGINEERING SIGNIFICANCE

Those of us working in agriculture today may well stop to consider what can and will happen in the future. Has the work in agricultural engineering been completed or what is there left for us to do? Let us examine some of the characteristics of agriculture in this country that are of interest especially to the agricultural engineer. This should help to evaluate our present status and perhaps guide us in future planning and work.

Annual address of the President of the American Society of Agricultural Engineers before the 42nd annual meeting of the Society at East Lansing, Michigan, June, 1949.

ARTHUR J. SCHWANTES is professor and chief, division of agricultural engineering, University of Minnesota.

Efficiency in the utilization of labor on farms in this country is the highest in the world. The U. S. Department of Agriculture states that agricultural production in the United States today is larger by one-third than before World War II, with the farm population nearly 10 per cent smaller and practically no increase in the total acreage planted to crops.

The United States Census data for 1935 compared with those for 1945 reveal an interesting and significant trend in farm size and population. During that period the amount of land in farms in the United States increased 8 per cent, but the number of farms decreased considerably more than that, namely, 14 per cent from 6,812,000 in 1935. (The number of farms in 1935 is the highest in the history of this country.) This necessarily resulted in an increase in the average size of farms. The increase in size during this period, from about 155 acres in 1935 to 195 in 1945, is 26 per cent. At the same time the total farm population decreased approximately 21 per cent. These data present rather clearly the trend toward larger scale operation. They show that the amount of work which one farm worker can do has increased rapidly during this period, that evidently some farms are being dissolved and being absorbed by neighboring farms, and also that there is greater dependence on power and machinery for doing farm work.

The farm as a business enterprise is considerably larger today than it was 10 or 20 years ago. The investment in land, buildings, machinery, and equipment of all kinds is no small sum. In North Central Regional Publication No. 5* it is stated that the total amount of capital per farm, of those studied in the region, varied from $14,000 to $60,000. The farms were of moderate size. Farmers have considerable electrical and other specialized equipment that they did not have 15 years earlier.

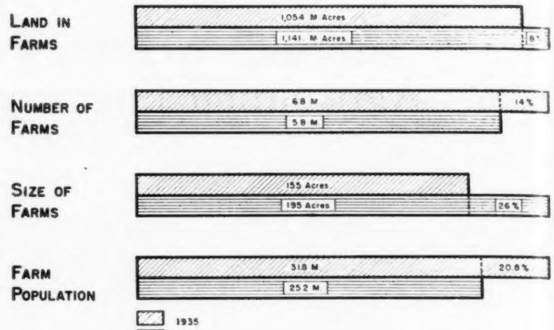
The farm is less self-sufficient, and to a greater extent the operator must be concerned with the necessity of meeting annual costs of operation. Proper management becomes increasingly important and keeping down the cost of production is one of the problems with which he is primarily concerned. This can be attained by use of good judgment in the purchase of supplies and equipment and through a better utilization of the factors of production which result in a larger number of bushels of corn or wheat, more tons of hay, more bales of cotton, more pounds of beef or milk against which to assess the total number of dollars representing the cost of production. Improvement in the grade of hay, cotton, or corn, will also bring an increased return provided the additional quality may be obtained at a reasonable figure.

The financial position of the farmer is extremely significant because the necessary capital investment of the individual farm unit is increasing as has been stated. Concerning this situation the following is quoted from Dr. Lowry Nelson†:

> "Following World War II farmers have been in a better position financially than they were in 1922. Farm income has risen. The net income from farming per person on the farm rose 280 per cent from 1940 through 1947. Farmers have smaller mortgage indebtedness. Many of them have savings in bonds and in bank deposits.
>
> "The question of vital importance to farm people, and to others as well, is this: How are farmers using the gains they have made? Will they be lost in another land boom as they were after World War I? Will the farm consolidate its gains or dissipate them? Will this improved financial position prove an asset or a liability?
>
> "If dollars, which might be used to contribute to a land boom, were used to improve the nutrition, housing, and education of the farm family, they would not only lessen the danger of land inflation, but would improve the standard of living of the farm family — thus adding to the sense of human satisfaction and well-being."

Dr. Nelson goes on to say that "increased farm income does not automatically translate itself into better standards of living. It may translate itself into a land boom. The kind of educational guidance farmers have now will certainly help determine their choices. These can stimulate the imaginations of farm families; can show the possibilities for improving standards of living in the farm house and rural community."

TREND IN FARM SIZE AND POPULATION
(UNITED STATES)



Agricultural engineers must make readily available for the farmer appropriate equipment, facilities and improvements at a cost that will make their use profitable; and through extension activities carry on educational programs that will assist the farmer in making important decisions to his advantage.

The American rural standard of living still has many things to be desired. Although two-thirds of the farms in the United States have electrical energy, only a small percentage have running water, flush toilets, and bathtubs. According to Dr. Nelson,

> "In 1940 there were 5,760,000 farm-operator dwellings on farms, and approximately one-third of these dwellings could be classified as acceptable‡, one-third as repairable**, and one-third, non-repairable††. In the case of 2,560,000 of the farms with these dwellings, it was estimated that either the farm, or a combination of farm and off-farm employment, produced enough to support acceptable housing. On these farms about two-fifths of the dwellings needed either replacement or major overhauling. On the remaining 3,200,000 farms, where neither farm nor combined farm and off-farm employment was sufficient to provide an acceptable dwelling, over four-fifths of the houses needed either replacement or major overhauling."

It is evident that many new homes are needed and many need repairing. Further, in spite of the favorable financial position of many farmers, the income on a large number of farms is not sufficient to support acceptable dwellings according to present standards.

Crop yield and per capita production on the North American continent in comparison with other parts of the world reveal significant situations. North America produces twice as much grain per person on a dry weight basis as our nearest competitor which is South America and more than three times as much as Asia. The average for the world is 722 in comparison with 1,859 for North America.

The yield in terms of pounds per acre on a dry weight basis on the North American continent, however, is almost identical with what it is in South America and in Asia. The values being 1,058, 1,066, and 1,064 lb, respectively. It is evident that while we have been successful in making it possible for one worker to accomplish much more than in other parts of the world, we apparently have been no more successful in making two blades of grass grow where one grew before than in other areas such as India and China where most of the work is done by hand. Our large-scale machinery and production methods extend the efforts of the individual worker but evidently have not been particularly effective in bringing about high yields. So far as total production is concerned, it might be of interest to note that about 20 per cent

* Minnesota Agricultural Experiment Station Bulletin 389. August, 1947. "Capital Needed to Farm in the Midwest". North Central Regional Publication No. 5.

† "Can Farmers Afford to Live Better?" Planning Pamphlet No. 65. National Planning Assn., 800 - 21st St., N. W., Washington 6, D. C.

‡ "Acceptable" is defined as houses with at least five rooms and a value in 1940 of at least $1000.

** "Repairable" included houses with three or four rooms and a value of $500 or more, and larger units if the value was between $500 and $1000.

†† "Non-repairable" were dwellings which had only one or two rooms, and larger units with a value of less than $500.

of the world's food is produced in North America and about 68 per cent is grown in Europe and Asia.

Agricultural practices and policies in this country have been influenced by natural conditions. We have had vast areas of agricultural land with a relatively small population. This no doubt stimulated the inventive genius of a resourceful people to devise machines which increased the output of the individual worker in order to take care of consumer need. As an example, the combine harvester is being used in practically all areas where cereal crops are grown. This has resulted in fewer man-hours per bushel of grain and in less hard work in producing the crop. As another example, we have introduced the field pickup baler and the field chopper for making hay. These result in savings in labor, reduction in storage space, and convenience in handling. The quality of work and of the product has, however, not been given the same emphasis as savings in labor in these and similar developments. There is great need for more study of methods and practices with the view of conserving and improving the quality of the product.

While considerable progress has been made in the improvement of buildings, our farmers are still asking for designs that better provide for the functional requirements of the animals that are to be housed. The average farm needs buildings that are more nearly suited to the specific requirements for which they are intended and which can be built at a cost that the business can afford. The farm home must be included in any building program looking toward greater efficiency of the farm as a unit.

We have gone only so far with soil conservation and land reclamation measures as necessity has dictated. It is estimated that many millions of acres of good agricultural land in this country can be benefited by drainage at a cost that would be economically feasible. We are only beginning to realize that the application of irrigation water to supplement an undependable distribution of rainfall is profitable for certain field crops under a much larger variety of conditions than has heretofore been practiced. Such practices are now beginning, for instance, in Texas for wheat, in Georgia for cotton, and in Minnesota for potatoes and sugar beets.

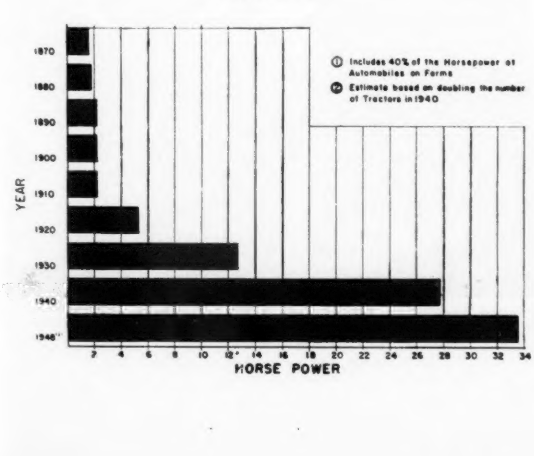
A CHALLENGE TO THE AGRICULTURAL ENGINEER

Farming tomorrow must be done more scientifically and more precisely than was necessary yesterday. This means that the agricultural engineer must put more and more emphasis on increased production, improvement of quality, and, above all, betterment of living conditions.

Better control of the factors of agricultural production might well be considered a principal objective of future activity in agricultural engineering. Farming has always been considered a most hazardous venture from a business point of view. In carrying out the basic and therefore the most important of his activities, the production of crops, he is always subject to temperature, humidity, and rainfall about which he has been able to do little or nothing. It is not uncommon that

HORSEPOWER PER AGRICULTURAL WORKER

IN THE UNITED STATES



seasonal variations in one or more of these factors may influence the yield on a particular farm by as much as 50 per cent, and of course we know that crops can be ruined entirely by unusual weather conditions. While we still have not learned to control rainfall or temperature, there are many ways in which the farmer may, in a measure, at least, guard against the results of irregularities in their extent or occurrence.

One of the important factors influencing yield is soil moisture control. There are in the United States still millions of acres of productive land to be improved by drainage. Good drainage can be accomplished on vast areas of fertile land at a cost that will be repaid in a few years through higher yields and more dependable crops.

Similarily the addition of water in terms of supplemental irrigation can be profitable not only under conditions of high-yielding crops, but also for general farm crops on good lands where other factors of production are satisfactory. Frequently the quantity of water needed to save a crop during a drought is not very large. The average annual cost of providing this water need not necessarily be high. It is a matter of providing the right amount of moisture at the critical time to help insure a reasonably good yield that might otherwise be a mediocre crop or a total loss.

Advanced practices for conserving the top soil must be encouraged. Soil is the farmers long-time capital without which he cannot continue to do business. While judgment must be used in the investment of facilities for preventing the loss of these soils, they need not necessarily be expensive. Farming practices that are appropriate for the particular soil, slopes, and climate must be adopted.

It is well known that the addition of commercial fertilizers on many of our agricultural lands results in increased yields at a profit. While some progress has been made in their intelligent application, we are in need of basic information concerning methods of placing, especially its location with reference to the seed or plant.

The corn belt farmer will be interested in a practical method of reducing the moisture content of his crop when nature prevents maturity in the field. Very heavy losses may result in a season which proves to be too short for completely ripening the corn. The cost of conditioning under those circumstances is small in comparison with the losses that may result. The farmer needs dependable facilities for conditioning at a reasonable cost. It is not inconceivable that with appropriate drying facilities for shelled corn it would be profitable to do the shelling at harvest time and eliminate the intermediate step of storing ear corn in the crib. This latter step always results in some losses due to handling and frequently considerable losses in spoilage and by rodents.

Hay is one of the most important feed crops grown in this country. In the natural curing process a large percentage of the feeding value which exists in the grass when it is cut is lost. The farmer is in need of a practical method of conserving these nutrients. He has already spent considerable time and money to produce the grass and is justified in increasing the cost of harvesting to a reasonable extent if it will insure a better quality product. Improved conditioning of farm products may be extended to include a large number such as the cereals, cotton and cotton seed, rice, soy beans, peanuts, and legume seeds.

It does not require a stretch of the imagination to visualize many other ways in which the farmer can exercise better controls over his operation, such as properly designed shelters for livestock to produce optimum environmental conditions for production, adequate and effective storages for crops, and methods of conditioning and handling milk and other dairy products. There are great possibilities for the application of electrical controls. This includes not only individual controls such as time switches, thermostats, or load limiters, but also centralized control systems for regulating a number of units on a system. Signals and calls to various parts of the farmstead are being experimented with.

Agriculture today is more conscious of the need for engineering than ever before. The agricultural engineer has almost unlimited opportunities to meet this challenge.

New Sweet Potato Equipment: Sweeps and Digger

By Joseph K. Park
MEMBER A.S.A.E.

SWEET potatoes are generally cultivated with hand hoes and mule-drawn plows. Naturally, therefore, cultivation adds considerably to the total cost of producing the crop. A few larger growers use tractor cultivators but, except under the most perfect conditions, are unable to get satisfactory results.

The major diffculty is that standard tractor cultivators are not designed to provide for changes in bed height. If beds were absolutely uniform at cultivating time, there would be no problem, but they are generally far from uniform. Even if the beds are reasonably uniform at the time they are built, uneven settling and washing makes them vary considerably at cultivating time. Variable soil conditions, inaccurate tractor driving, and changes in plow depth all tend to produce variations in bed cross section.

The various sweeps on a standard tractor cultivator are set to fit a particular bed cross section and are not satisfactory when the cross section changes. Bed height often varies as much as 4 to 7 in in a single row. This causes the sweeps on top of the beds to vary in depth from 4 in deep to completely above the ground surface. Since these sweeps are running close to the plants, they cut a large number of roots when they go too deep where the bed is high. Where they miss the bed entirely in low spots, a weed patch grows.

The only remedy for this situation is to provide a floating-type sweep which will plow at a uniform depth regardless of changes in bed height. During the past season, we built a simple cultivator attachment (Figs. 1 and 2) utilizing a horizontal bearing which allows the sweep to move freely up and down as bed height changes. A slide running just ahead of the sweep serves as a depth gage. This is adjustable to provide the desired depth of cut. Use of this sweep in several fields and under various conditions gave highly satisfactory results. For the first time, we were able to do a really good job of tractor cultivation. In an attempt to devise a floating-type sweep which would be more compact and would more closely resemble present equipment, we built an attachment which used a vertical bearing (Fig. 3). This was also used successfully, but is probably less practical than the original design because of bearing friction and original cost. It seems reasonable that floating sweeps of the type discussed should be equally valuable in cultivating many other crops, particularly crops grown on ridges.

There has long been a need for more complete information on the underground distribution of sweet potatoes. This knowledge is essential in the design *(Continued on page 335)*

This paper was presented at a meeting of the Southeast Section of the American Society of Agricultural Engineers at Baton Rouge, La., January, 1949.

JOSEPH K. PARK is agricultural engineer (BPISAE), U. S. Department of Agriculture, cooperating with the South Carolina Agricultural Experiment Station, Clemson, S. C.



Fig. 1 (*Left*) Floating-type sweep built by USDA and South Carolina agricultural engineers • Fig. 2 (Center) Floating sweeps used on a tractor • Fig. 3 (*Right*) Floating sweep using vertical bearing

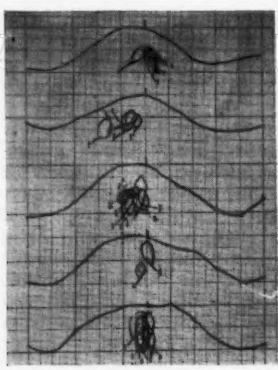
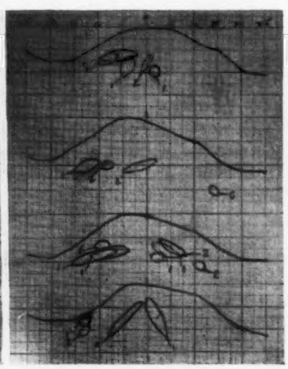



Fig. 4 (*Left*) Five random hills from a field of closely grouped potatoes • Fig. 5 (*Right*) Four random hills from a field of poorly grouped potatoes

Fig. 6 An experimental sweet potato digger

Air Flow in Poultry House Ventilation—A Theoretical Analysis

By L. L. Sammet and H. J. Barre
MEMBER A.S.A.E. MEMBER A.S.A.E.

PRACTICAL experience and experimental work with poultry have shown that a wide variation in environmental temperature can be experienced without detriment to the health of the birds or to production. Accordingly it is not essential to provide a constant temperature; this, as a matter of fact, would be extremely difficult and impracticable. On the other hand, it is essential that moisture produced by the birds be removed continuously; otherwise wet litter will contribute to serious losses from disease and, in cold weather, severe damage to the structure will result because of condensation on the building surfaces.

The problem of poultry house ventilation has been the subject of much study and experiment, most of which has involved practical tests in actual houses. In general such tests, while productive of valuable practical observations, have failed to yield data and methods on which can be based a rational, or calculable, analysis. Such an approach has been made, however, by Strahan[1]*. In this article the authors present a method for estimating the rate of air flow required in poultry house ventilation which essentially is a modification of the analysis developed by Strahan.

This paper was prepared expressly for AGRICULTURAL ENGINEERING, as a contribution (Journal Paper No. 397) from the department of agricultural engineering, Purdue Agricultural Experiment Station.

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* Superscript numbers refer to appended references.

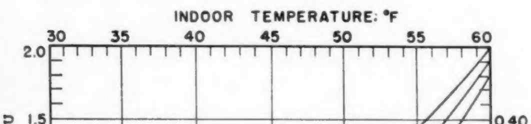


Fig. 1 Air flow in poultry house ventilation. (Air flow based on assumption of no condensation: latent heat equivalent = 17 Btu per hen (hr); sensible heat, 43 Btu per hen (hr); temperature variation as indicated; maximum indoor relative humidity, 80 per cent; outdoor relative humidity, 80 per cent)

FACTORS AFFECTING VENTILATION REQUIREMENTS

The necessary rate of ventilation in a poultry house is affected by the number, breed, and age of the birds; the rate of feeding and production (or growth); the environmental temperature, relative humidity, and rate of air movement, and by other factors. These influences are interdependent. For example, the amount of moisture generated by the birds varies with the relative humidity and ambient temperature; these, in turn, depend on the rate of air movement through the house, the outdoor air temperature and relative humidity, and the amount of heat loss through the building surfaces in relation to that generated within the house. In estimating ventilation requirements, it also must be recognized that data on some of the essential factors—the heat and moisture production of the birds, for example—are available on an approximate basis only. It thus is necessary that certain reasonable assumptions be made as a basis for analysis. For present discussion the following conditions are assumed:

1 *Type of Birds.* To simplify the problem, the analysis is limited to a house containing laying hens in which the average body weight is 4 lb.

2 *Environmental Temperature.* The optimum temperature for poultry production is not known. There is experimental evidence to indicate that production falls significantly at temperatures above 70 F, but that production is not affected adversely at temperatures as low as 10 F. At the lower temperature, however, there is some danger that combs and wattles may freeze. Temperatures below freezing are a considerable disadvantage with respect to labor efficiency and the freezing of water systems. A desirable working range of indoor temperatures is assumed to be 30 F to 70 F.

In practical operations the only heat source in a laying house is the body heat of the birds. Since the rate of heat production is practically constant for a given rate of feed consumption, it is evident that the indoor temperature must vary to some extent with outdoor temperatures. The variation in indoor temperature can be modified in relation to outdoor temperature, however, by adjusting the rate of ventilation. The following indoor and outdoor temperatures are assumed to be obtainable under practical conditions of house construction and management.

TABLE 1. Assumed Indoor-Outdoor Temperatures

Outdoor temperature, deg F	Corresponding indoor temperature, deg F
-10	30
0	35
10	40
20	45
30	50
40	55
50	60

The assumed outdoor temperatures are limited to the range -10 to 50 F since temperatures below -10 F are rarely encountered, and at outdoor temperatures higher than 50 F the rates of air flow necessary to maintain a desirable indoor temperature are so high as to make controlled ventilation impracticable, the house must be operated on a more or less "open" basis.

3 *Relative Humidity.* Experimental data on the optimum relative humidity are lacking. It undoubtedly is true that poultry can adjust satisfactorily to a considerable range of relative hu-

midity, and that they are handicapped by high relative humidity if it is accompanied by high temperature. If the relative humidity is too low, it may result in excessively dry and dusty litter, which may contribute to respiratory irritation. For the analysis that follows, a maximum relative humidity of 80 per cent is assumed.

4 *Heat and Moisture Production.* The amount of heat and moisture produced by poultry has been estimated by Mitchell and Kelley[2] as 40 Btu per hr per 4-lb hen. This figure has been widely used in estimating ventilation requirements. This heat estimate is interpreted as accompanying maintenance and voluntary activity (no growth or production) for which the feed requirements are 72 g dry matter per day per hen. For birds producing at the average rate of 220 eggs per year, the quantity of feed consumed would be considerably greater. It would be still greater during the period of highest production. Since the high production rate occurs during the cool months, when ventilation for moisture removal is most critical, a production rate of 275 eggs per year is chosen for purposes of analysis. At this rate of production the feed requirement is estimated as 109 g per hen per day (based on data quoted by Jull[3]). If heat production is assumed to be proportional to the total dry matter fed (an admittedly rough assumption), the total heat generated is approximately 60 Btu per 4-lb hen per hour.

The amount of moisture respired by the hen decreases as the environmental temperature falls. At environmental temperatures below 50 F about 10 per cent of the total heat appears as latent heat in respired moisture†. Unless removed by ventilation the respired moisture will condense within the building. If condensation does not occur within the building, the latent heat in the respired moisture is not available for control, of indoor air temperature.

In addition to the respired moisture it also is necessary to remove by ventilation most of the excreted moisture. At a feeding rate of 109 g per hen per day, excreted moisture is estimated to be about 0.27 lb per day, the latent heat equivalent of which is 270 Btu, or at the rate of 11 Btu per hen per hour.

From the foregoing estimates, and assuming continuous removal by ventilation of expired and excreted moisture, the total heat production of 60 Btu per hen per hour is divided as: 17 Btu latent heat; 43 Btu sensible heat.

COMPUTATION OF AIR FLOW REQUIRED

If all moisture produced in the house is to be removed by ventilation, the rate of air flow required is given by the equation

$$M_L = \frac{W_e}{W_o - W_i} \qquad [1]$$

† The proportion of latent heat increases as the environmental temperature rises. The rate of increase is slow until a temperature of about 75 F is reached. Since poultry house ventilation for moisture control is not critical at the higher temperatures, and the analysis is necessarily approximate, the assumption of a constant ratio of latent to total heat appears to be a justifiable simplification. One should also note that available data as to the proportion of latent heat at various environmental temperatures is based on observations under conditions of fast and resting. Under conditions of normal or heavy feeding, the proportion of latent heat may be significantly larger, especially at high environmental temperatures.

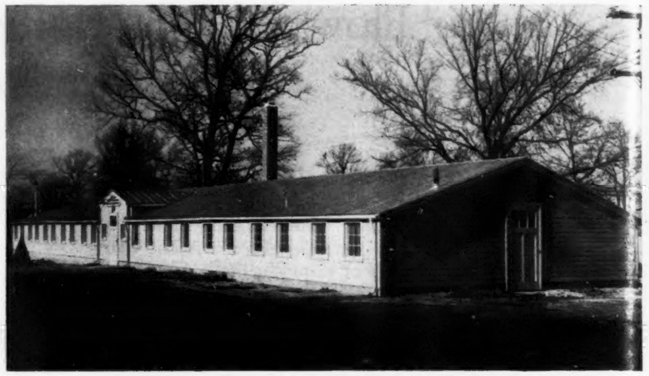


Fig. 2 Typical one-story poultry house

in which M_L = air flow required, pound per hour

W_e = weight of moisture to be removed per hour

W_o and W_i = weight of moisture in each pound of outgoing and incoming air respectively (pound of water vapor per pound of dry air).

As a matter of convenience the above equation may be transformed (a) by expressing W_e as a function of the latent heat in the evaporated moisture —($W_e = Q_L/1043$), in which Q_L is the total latent heat of moisture vaporized and the number 1043 is the latent heat per pound of water evaporated at body temperature— and (b) by dividing both sides of the equation by the *sensible* heat available from the birds so as to obtain the air flow per Btu of sensible heat. The equation then becomes

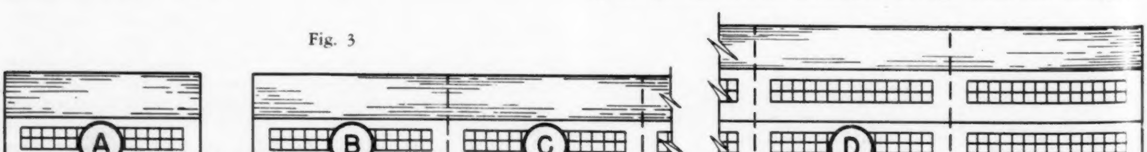
$$\frac{M_L}{Q_s} = \frac{Q_L}{Q_s\,(W_o - W_i)\,1043} \qquad [2]$$

Equation [2] may now be solved to obtain the air flow required for ventilation at the temperatures assumed in Table 1. This is done by substituting for Q_L and Q_s the latent and sensible heat produced per hour per hen; and for W_o and W_i the weight of vapor per pound dry air corresponding to the assumed temperatures and relative humidity. The results of such computations for outdoor temperatures, –10 F to 50 F, are represented in Fig. 1 by the heavy solid curve, M_L. Thus at an outdoor temperature of 30 F (assumed indoor temperature, 50 F) the air flow required for moisture removal is 0.11 lb per hr per Btu sensible heat. For a hen producing 43 Btu sensible heat per hour, this amounts to 4.73 lb of air per hour, or approximately 63 cu ft per hour per hen. This appears from Fig. 1 to be the minimum rate of air movement that the assumed conditions will permit.

The M_L curve in Fig. 1 is based on the temperature relations given in Table 1 and on an assumed indoor and outdoor relative humidity of 80 per cent. Different values and a different curve would be obtained by making different assumptions as to temperature, relative humidity, and heat and moisture production.

In the foregoing equations air flow required for moisture removal is computed without regard for temperature control. The equation presumes that the assumed indoor temperature will be maintained. The indoor temperature, however, is affected by the amount of heat exchanged through walls and ceiling, as

Fig. 3



A: Individual pen B: End pen-one story hse. C: Inside pen-one story hse. D: Inside pen-two story house

well as by ventilation. Hence the area of wall and ceiling surfaces in relation to the heat produced and the amount of insulation employed must be considered a part of the ventilation problem. To do so it is necessary to resort to another equation in which the sensible heat lost from the building is expressed as the sum of the sensible heat removed by ventilation and the sensible heat transmitted through walls and ceiling. Thus

$$Q_s = M_s\,(S_a)\,(t_o - t_i) + AU_{av}\,(t_o - t_i) \qquad [3]$$

in which Q_s = sensible heat exchanged per hour

M_s = air flow in ventilation, pound per hour

S_a = specific heat of air = 0.24 for air at constant pressure

t_o and t_i = temperature of outgoing and incoming air, respectively, deg F

A = total area of heat exchange surfaces, deg F

U_{av} = the over-all heat transmission coefficient (Btu per hr per sq ft per deg F) for the entire building—a weighted average coefficient in which the heat transfer (U) value for each individual surface is included in proportion to its area.

If equation [3] is solved for air flow per Btu of sensible heat, it becomes

$$\frac{M_s}{Q_s} = \frac{1}{0.24}\left(\frac{1}{(t_o - t_i)} - \frac{AU_{av}}{Q_s}\right) \qquad [4]$$

a form in which the second right-hand term conveniently combines the factors relating to heat transfer through the building surfaces. This term, AU_{av}/Q_s, in physical units is the heat transferred through the building surfaces for a one degree of temperature difference divided by the sensible heat generated within the building. It is, in effect, an index which measures the heat retention characteristics of the exterior building walls, ceiling, etc., in relation to the heat available for maintaining the indoor temperature. The authors have designated this term as the "exposure ratio." A structure having a high exposure ratio is poorly insulated (or has a large surface area) in relation to the number of birds and the heat generated. For a low exposure ratio the reverse is true.

By assuming arbitrary values for the exposure ratio and taking $Q_s = 1$, equation [4] may be solved for air flow required to maintain any specified relation between indoor and outdoor air temperatures. Such a solution for the temperature relationships given in Table 1 is represented for exposure ratios of 0.005 to 0.025 by the dotted curves in Fig. 1.

From the air-flow curves of Fig. 1 the following observations may be made:

1 For a given exposure ratio there is only one point at which the rates of air flow for temperature regulation and for moisture removal are identical (e.g., for an exposure ratio of 0.020 this identity occurs at an outdoor temperature of approximately 26 F). For outdoor temperatures higher than the point of "identity", the rate of air flow required to maintain the assumed indoor temperature is higher than that required for moisture removal; for outdoor temperatures lower than the point of "identity" the ventilation must be restricted to an amount less than that required to remove moisture.

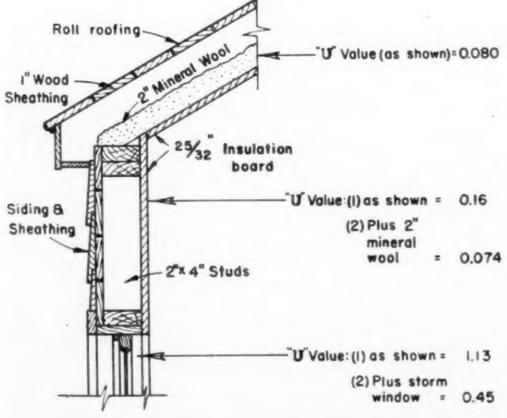


Fig. 4 Wall and roof section of poultry house

2 From the standpoint of providing adequate ventilation capacity during cold weather, it appears (Fig. 1) that an exposure ratio of 0.010 to 0.015 should prove satisfactory in most regions. With an exposure ratio of 0.010, ventilation adequate to remove all moisture is possible for temperatures down to 16 F, and for an exposure ratio of 0.015, to a temperature of 22 F. In a practical situation these minimum temperatures would be less because of condensation on the windows.

3 At times when the rate of air flow exceeds that required for moisture removal (when outdoor air temperature is higher than the "identity" point), the relative humidity will be less than the assumed value. When the air flow is restricted, the relative humidity will be higher than assumed, and condensation may occur.

VENTILATION CURVES APPLIED TO A PRACTICAL PROBLEM

Application of the curves in Fig. 1 to a practical problem can be observed by analysis of a typical poultry house (Fig. 2). The house illustrated is a one-story structure in which the basic unit is a pen 30x30 ft. The sidewalls are low and a portion of the ceiling sloping. While usually constructed as a single-story house, it will, for purposes of analysis, be assumed to be suitable for two-story construction.

To determine the air flow required for ventilation, it is first necessary to estimate the heat production of the birds. If it is assumed that each pen contains 300 4-lb laying hens, each occupying 3 sq ft of floor space, the total heat production per pen is $(30\text{x}30 \div 3)60 = 18{,}000$ Btu. Based on previous assumptions, 5100 Btu of this total represent latent heat of vaporization, and 12,900 Btu sensible heat.

From Fig. 1 it is clear that the rate of air flow required for moisture removal depends on the outdoor air temperature. The minimum rate (0.11 lb per hr per Btu sensible heat) occurs at about 30 F outdoor temperature. For 300 4-lb hens producing a total of 12,900 Btu per hr sensible heat, the air flow requirement per pen is $M_L = (12{,}900)(0.11) = 1419$ lb per hr per pen. Similar computations for air flow at –10, 30 and 50 F are summarized in Table 2.

TABLE 2. Air Flow Required for Moisture Removal From a Single Pen (300 Laying Hens at 4 lb each)

Outdoor temperature deg F	Air flow required for moisture removal			
	Per pen		Per bird	
	lb/hr	cu ft/hr	lb/hr	cu ft/hr
–10	2064	27450.	6.9	92
30	1419	18870.	4.7	63
50	1806	24020.	6.0	80

With respect to air flow required for temperature control, Fig. 1 indicates the required rate to depend on both outdoor temperature and the exposure ratio, AU_{av}/Q_s. For example, at –10 F the air flow corresponding to a 30 F indoor temperature and an exposure ratio of 0.025 is zero; for the same temperatures but for an exposure ratio of 0.005, the air flow required is roughly 0.08 lb air per hour per Btu sensible heat, both rates being considerably less than that required to remove all moisture. At 50 F outdoor temperature (60 F indoors) the corresponding rates of air flow are for an exposure ratio = 0.025, 0.31 lb air per hour; and for an exposure ratio = 0.005, 0.39 lb air per hour—rates much in excess of that required for moisture removal. At points of "identity" with the moisture removal curve, the rates of air flow are 0.11 lb per hr for an exposure ratio of 0.025 (31 F outside air temperature), and

0.12 lb per hr for an exposure ratio of 0.005 (outdoor temperature 11 F). These data are summarized in Table 3.

TABLE 3. Air Flow Required for Temperature Control (Pounds of air per hr per Btu sensible heat)

Air temperature, deg F		Air flow required for exposure ratio of	
Outdoor	Indoor	0.005 lb/hr (Btu sens. ht.)	0.025 lb/hr (Btu sens. ht.)
−10	30	0.08	0
11	41	0.12	0.04
31	51	0.19	0.11
50	60	0.39	0.31

How do the foregoing rates of air flow apply to the typical house? To answer this question requires evaluation of the exposure ratio and this involves consideration of the type of wall and roof construction and the location of the pen in the house. In a multipen house some pens obviously are more exposed to weather than others and therefore react differently with regard to ventilation. To illustrate these differences specifically an analysis of the typical house is made for the following locations (see Fig. 3):

1 An isolated pen (A) in which heat transfer occurs through all four walls and the roof. (It is assumed that the floor consists of concrete laid directly on the ground and that ground temperatures are such as to make heat flow through the floor relatively insignificant.)

2 The end pen in a multipen house (B) in which heat transfer occurs through the roof, front and back walls, and end wall but not through the floor or pen partition (adjacent pens are assumed to be at the same temperature).

3 An interior pen in a four-pen, single-story house (C) in which heat transfer occurs through the front and back walls and roof, but there is no exchange through the pen partitions and floor.

4 A first-floor interior pen in a multipen house (D). Heat transfer is assumed to occur only through the front and back walls, there being no heat flow to the ground, through the pen partitions, nor through the pen ceiling.

Two types of construction are considered. Wall and roof construction for Type 1 are assumed to be as illustrated in Fig. 4. An alternate construction (Type 2) is assumed to be identical to Type 1 except for the addition of storm windows and the use of 2-in thick mineral wool insulation in the walls. The area of each type of surface (windows, walls, roof) and the conductance (U value) are summarized in Table 4. The column ΣAU is the sum of heat losses occurring through each surface and represents the total heat loss through the building surfaces for a 1 F *temperature difference*. The column AU_{av}/Q_s is the exposure ratio, obtained by dividing the total sensible heat production for a 300-bird pen into the term ΣAU_{av}. In the final column of Table 4 is the outdoor temperature at which the temperature control and moisture removal curves of Fig. 1 intersect. Below this point of identity it is necessary to restrict the rate of ventilation to less than that required for removal of moisture; this might be described as a "minimum moisture control temperature." For the most exposed pen in construction Type 1 (Pen A) this critical temperature is approximately 26 F; for the least exposed pen (Pen D) the critical temperature is approximately 14 F. The corresponding "identity" temperatures for construction 2 are, in Pen A, 17 F; in Pen D, 8 F.

The range in "minimum moisture control temperature" (Table 4) illustrates clearly the difference in exposure resulting from the location of the pen. These critical temperatures show in a quantitative way what is obvious to the casual observers, namely, (1) as the amount of insulation is increased (exposure ratio reduced) controlled ventilation is possible at lower outdoor temperatures, and (2) controlled ventilation at lower outdoor temperatures also is possible for interior pens, as compared with exterior pens of a multipen house, or single, isolated pens.

CONDENSATION ON BUILDING SURFACES

An important assumption in the foregoing discussion is that there be no condensation within the house. This is a condition, however, which cannot be assured by ventilation alone: the rate of ventilation and *air* temperatures may be adequate for removal of all moisture, yet there may be condensation on walls or windows because of low *surface* temperature.

For a known wall construction it is possible to calculate the surface temperature, assuming outdoor and indoor temperatures are known. The surface temperature may then be compared with the wet-bulb temperature of the indoor air to determine whether or not condensation will occur. This can be illustrated by example. Assume a house in which the exposure ratio is 0.015, the outdoor air temperature is 25 F, and the indoor air temperature is 47.5 F. The rate of air flow required under these conditions (Fig. 1) is 0.125 lb air per hour per Btu sensible heat, this being the rate necessary to provide the assumed indoor temperature. Since the required rate is higher than that needed for moisture removal, the actual relative humidity in the house would be less than the 80 per cent assumed in the construction of the moisture-removal curve. The actual relative humidity may be estimated from equation [1]. This equation, when $Q_s = 1$ (and assuming $Q_L = (17/43)\ Q_s$), may be written

$$M_L = \frac{\dfrac{(17/43)\ Q_s}{1043}}{W_o - W_i}$$

or

$$W_o = \frac{0.000379}{M_L} + W_i$$

From the psychrometric tables, outdoor air at 25 F and 80 per cent relative humidity contains 0.00219 lb of water vapor

TABLE 4. ANALYSIS OF VENTILATION REQUIREMENTS IN POULTRY HOUSE*

Pen No.	Roof: A, sq ft	Roof: U value ‡	Roof: AU, Btu/hr	End wall: A, sq ft	End wall: U value ‡	End wall: AU, Btu/hr	Front and rear walls: A, sq ft	Front and rear walls: U value ‡	Front and rear walls: AU, Btu/hr	Window glass: A sq ft	Window glass: U value ‡	Window glass: AU, Btu/hr	ΣAU, Btu/hr	Exposure ratio, AU_{av}/Q_s	Minimum moisture control temperature, deg F
							Construction 1								
A	910	0.08	73	396	0.16	64	270	0.16	44	48	1.13	54	235	0.018	26
B	910	0.08	73	198	0.16	32	270	0.16	44	48	1.13	54	203	0.016	23
C	910	0.08	73	......	......	......	270	0.16	44	48	1.13	54	171	0.013	20
D	......	......	......	......	......	......	270	0.16	44	48	1.13	54	98	0.008	14
							Construction 2†								
A	910	0.08	73	396	0.07	28	270	0.07	20	48	0.45	22	143	0.011	17
B	910	0.08	73	198	0.07	14	270	0.07	20	48	0.45	22	129	0.008	15
C	910	0.08	73	......	......	......	270	0.07	20	48	0.45	22	115	0.007	12
D	——	......	......	......	......	......	270	0.07	20	48	0.45	22	44	0.003½	8

* For air conditions specified in constructing Fig. 1.

† Construction identical with Type 1 except for addition of storm windows and use of 2-in thick mineral wool insulation in walls.

‡ Units = Btu per sq ft per deg F per hr.

per pound of dry air. The actual rate of air flow (Fig. 1) is 0.125 lb per hr. Substituting

$$W_o = \frac{0.000379}{0.125} + 0.00219$$

$$= 0.00527 \text{ lb of water vapor per pound of dry air}$$

At the indoor air temperature of 47.5 F this water vapor content corresponds to a relative humidity of 75 per cent and a wet-bulb temperature of 40.2 F. From this it appears that condensation within the building will occur on any surface having a temperature lower than 40.2 F.

For the house under consideration (construction 1) the most poorly insulated portion is the single-window glass. It can be shown that the temperature of the indoor glass surface is given by the equation

$$t_s = t_i - \frac{R_s}{R}(t_i - t_o) \quad [5]$$

in which t_s = glass surface temperature, deg F

t_i and t_o = indoor and outdoor air temperatures, respectively, deg F

R_s = the surface heat resistance coefficient of the inner glass surface = 0.61

R = over-all heat resistance of the glass = 0.88

Substituting in equation [5]

$$t_s = 47.5 - \frac{0.61}{0.88}(47.5 - 25)$$

$$= 32 \text{ F}$$

Since the glass surface temperature is lower than the wet-bulb temperature of the indoor air (40.2 F), condensation on the windows will occur.

The analysis may now be carried one step farther to determine the conductance at which surface condensation begins to form. This involves solving equation [5] for an unknown over-all resistance R by substituting a predetermined surface temperature t_s = 40.2 F, the wet-bulb temperature of the indoor air. For an indoor surface coefficient $R_s = 0.61$, equation [5] becomes

$$40.2 = 47.5 - \frac{0.61}{R}(47.5 - 25)$$

$$R = 1.88; \; U = \frac{1}{1.88} = 0.53$$

The "condensation" curves of Fig. 1 have been plotted from computations similar to the above. The curves give directly the maximum conductance that may exist for any exterior wall if condensation is to be prevented. While the limiting conductance is a function of numerous and complex variables, the relationship is expressed in Fig. 1 as a function of only two, the outdoor temperature and the exposure ratio.

SUMMARY

1 Based on a review of the literature, mature poultry are assumed to be able to adjust readily to air temperatures from -10 F to 70 F (assuming large temperature changes do not occur suddenly). For winter operating conditions an outdoor temperature range of 10 F to 50 F is assumed; a desirable and practical range of corresponding indoor temperatures is assumed to be 30 F to 60 F. For practical operating conditions indoor temperatures are assumed to vary, but not to fluctuate as much or as rapidly as outdoor temperatures.

2. A maximum indoor relative humidity of 80 per cent is assumed; for actual operations it normally would be less, except for short periods of unusually severe conditions.

3 The total heat production of a 4-lb hen producing at an annual rate of 275 eggs per year and consuming feed at the rate of 109 g per day is estimated as 60 Btu-per hr. (This is considerably greater than the 40 Btu per hr generally used in poultry house ventilation studies.) It is estimated that at indoor temperatures less than 50 F and for a feeding rate of 109 g dry matter per day, 17 Btu of the total heat is required, on the average, for the vaporization of moisture. The total heat production thus is estimated to be divided as 17 Btu latent heat and 43 Btu sensible heat.

4 The relation between heat input from the birds and the area and heat conductance of exposed wall and ceiling surfaces is defined as the "exposure ratio" and is expressed as AU_{av}/Q_s.

5 On the basis of the above assumptions curves are developed which, for an outdoor temperature range of -10 F to 50 F, give approximations for (a) the rate of air flow required for moisture removal, (b) the rate of air flow required for maintaining assumed indoor temperatures at five different exposure ratios, and (c) the maximum conductance, for each exposure ratio, that may be tolerated on exposed walls, windows, etc., if there is to be no condensation. The curves make it possible, on an approximate basis, to select a critical minimum temperature above which all moisture is to be removed by ventilation; then by a direct procedure to compute the U value required for each exterior surface.

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New Sweet Potato Equipment

(Continued from page 330)

of harvesting equipment. During the past season, we dug by hand and made cross sections of about 200 individual sweet potato hills chosen at random in fields throughout the South Carolina sweet potato belt.

Although space will not permit a detailed discussion, it is interesting to note that tremendous differences occur in underground distribution, even in the same field. The effect upon harvesting is obvious. Close grouping of the sweet potatoes means easy harvesting; wide spreading means excessive cutting and bruising and many roots left in the ground. Very little is known about the factors which affect distribution. There are indications that planting date, weather conditions, soil, variety, and cultural methods may all be determining factors. It was notable that high quality and good shape were always accompanied by close grouping. A closely grouped field can be dug with a 12-in plow with very little bruising, but where the sweet potatoes spread, a digger 30 in wide running 15 in deep is necessary.

Fig. 4 shows five random hills from a field where the sweet potatoes were well grouped. Fig. 5 shows five random hills from a field where grouping was very bad. Note that in Fig. 4 a 14-in plow would do a reasonably good job of digging, but in Fig. 5 a digger about 30 in wide running 15 in deep would be required. Analysis of the data collected on root distribution indicates that in the average field the commonly used 14-in plow running 11 in deep would either damage or miss completely about 22 per cent of the marketable sweet potatoes.

Since this study indicated that a 14-inch plow is inadequate in most fields, a new plow (Fig. 6) was designed to cover a strip 22 in wide. Extensions were welded to each side of a middlebuster point, the wings were shortened, and special rods were attached to bring the sweet potatoes to the top of the soil. The rods are supported by the bottom of the furrow and staggered to prevent clogging. Exposure tests under identical conditions averaged 60 to 65 per cent for standard turning plow and middlebuster and about 90 per cent for the new digger. This digger was used to harvest about 30 acres at Edisto and daily harvests ran considerably higher than with other plows. It was the general opinion that this was the best tool yet tried for digging sweet potatoes. Work on this plow was done in cooperation with M. R. Powers, agricultural engineer, Edisto branch, South Carolina Experiment Station.

A Diagram for Determining Wall-Surface Condensation

By Alfred D. Edgar
FELLOW A.S.A.E.

CONDITIONS for wall-surface* condensation are of particular interest to those designing storage and livestock buildings although the subject is also of interest to those working upon other problems of insulation, temperature, humidity, and dew point.

While the problem of determining wall insulation to avoid surface condensation for one set of temperature and humidity conditions may be quickly solved with the aid of psychrometric tables, time-consuming calculations may be required for a whole series of conditions in designing a storage building.

However, conditions for wall-surface condensation can be quickly determined by means of the accompanying diagram when any three of the following four factors are known:

T_c = air temperature on colder side of wall

T_w = air temperature of warmer side of wall

U = over-all thermal conductivity of wall between T_c and T_w

RH = relative humidity of air on warmer side of wall.

For condensation, the warmer side wall surface is at or below the dew point temperature, T_{dp}, of the air on the warmer side of the wall (1).

Lines of air temperature, T_w, for the warmer side of the wall run through intersections of lines for corresponding dew-point temperatures, T_{dp}, and relative humidity, RH at 30 in of mercury (2).

Over-all thermal conductivity, U, includes internal conductance and that of both surfaces or films, of which the warmer side, still air-surface conductance, f = 1.65 Btu† (3).

Surface and dew-point temperatures, T_{dp}, are located at the intersections of the horizontal thermal conductivity lines, U, and a straight edge between air temperatures, T_c, on the colder side at the bottom and air temperatures, T_w, on warmer side, at top† (4).

EXAMPLE

To Find: Relative humidity, RH, for condensation on warmer side surface (1) when

Air temperature on colder side, at bottom, T_c = 6 F

Air temperature on warmer side, saturation line, at top, T_w = 74 F

Over-all thermal conductivity, U = 0.36 Btu.

Solution: Intersection of horizontal, U = 0.36 line and diagonal straight edge between T_c = 6 F and T_w = 74 F (bottom to top) locates T_{dp} = 57 F (3) (4).

Intersection of vertical dew point, T_{dp} = 57 F, and curved air temperature, on warmer side, T_w = 74 F line, at RH locates horizontal relative humidity, RH = 56 per cent line (2).

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

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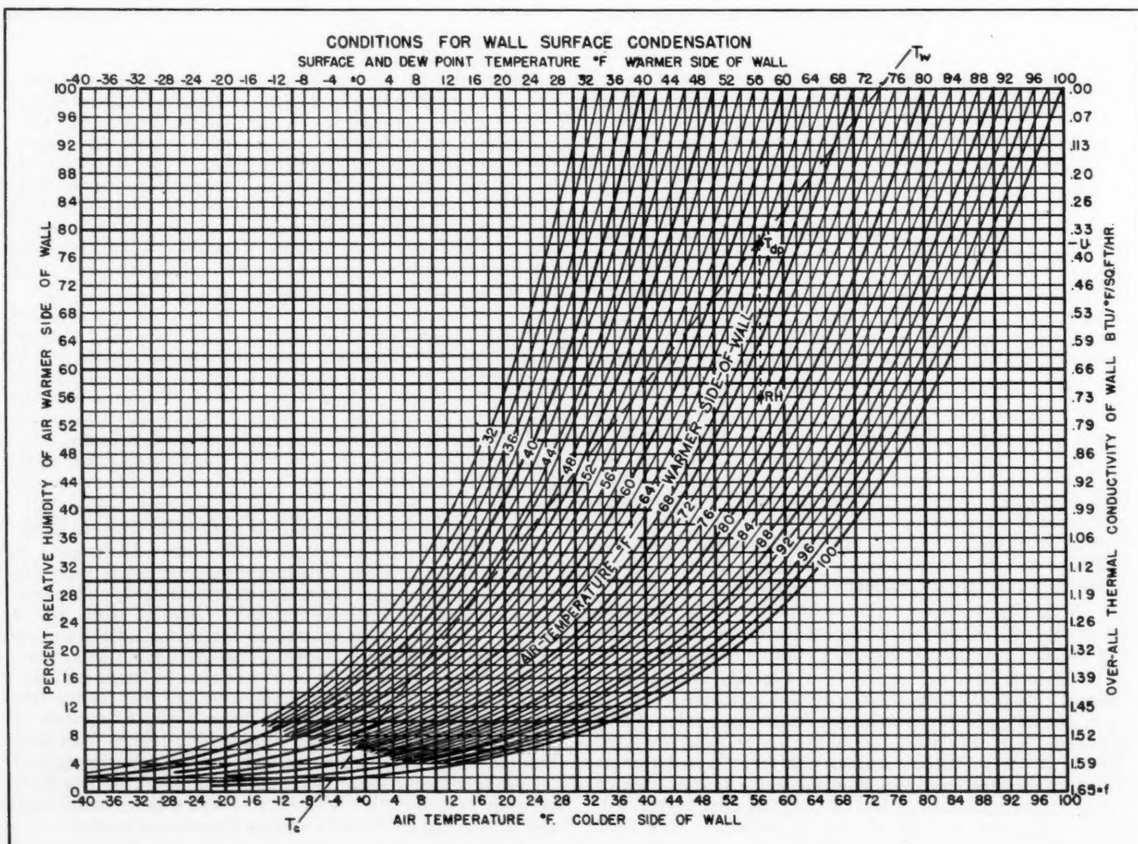
* As used here, the term "wall" applies equally to floors or ceilings.

† NOTE: Values of U = per cent (downward from top to bottom) × f, or per cent = U/f. To locate T_{dp} corresponding to U, the per cent (right to left, T_w to T_c) locates T_{dp} where $U/f = (T_w - T_{dp})/(T_w - T_c)$.



Pineapple Production Equipment

By Eugene G. McKibben
FELLOW A.S.A.E.

As IS usual with most specialty crops, the production of pineapples in Hawaii presents special and, in some instances, unique problems from the standpoint of field machinery. Some of these problems result from such factors as the relative skill of workers, isolation of plantations, relatively small total industry acreage, and the particular characteristics of local soil, topography, and climate, as well as the special characteristics of the pineapple plant itself.

On the other hand, the development and introduction of new equipment is greatly aided by (1) the value of pineapple yields per acre in comparison with many field crops, (2) the large number of hours of use per year under Hawaii's year-around tourist-quality climate, and (3) the organization of field production on the basis of large plantations. This is particularly true with respect to the adoption of large, complicated, and expensive machines.

Workers. Many workers on Hawaiian pineapple plantations are skilled and entirely competent. The average level of skill and interest in the job at hand is, however, probably less than that of mainland owner-operators or custom-operators, who either actually handle or closely supervise the operations of a large proportion of the more complicated machines used in American agriculture. The successful mechanization of most of the field operations on pineapple plantations is no small tribute to the effectiveness of the administration of these plantations and the reliability of the tractors upon which this development is based.

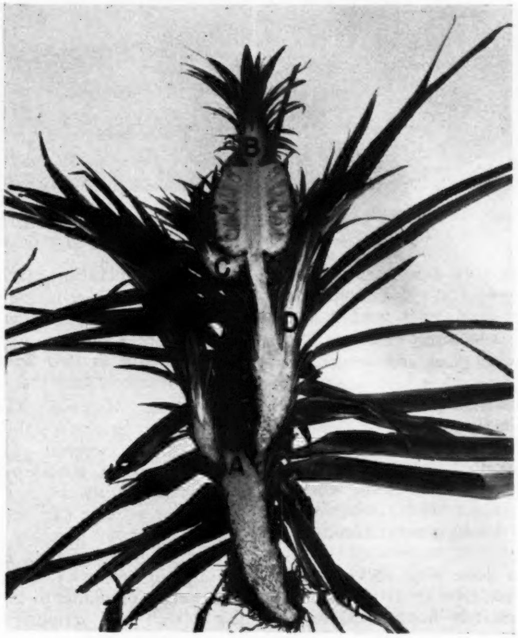


Fig. 1 Three-year-old pineapple plant with second-crop (first ratoon) fruit. A, point from which first crop (plant crop) was taken. B, crown; C, slip, and D, sucker, are the three sources of planting material

Distance. The distance, including 2,000 miles of ocean, from the centers of agricultural machine and tractor manufacture, and from the primary sources of construction materials and machine elements, is a factor which must be constantly considered. More than usual attention must be given to the plantation's inventory of machine parts. Frequently repair or even new construction must be made with what is available rather than what is wanted.

Small Acreage. Only about 68,000 acres are devoted to pineapples in the Hawaiian Islands. Because of this small total acreage, the quantity of any particular machine needed is too small to interest large farm-equipment companies. Therefore, most of the equipment for pineapple production must be virtually custom-built in plantation shops or by specialty shops in Honolulu or on the Pacific coast of the mainland.

Soil Conservation. A considerable portion of this relatively small pineapple acreage is steep enough to require soil-conservation measures such as contour planting and/or terracing. The need for such soil-conservation practices, even on relatively flat grades, is greatly increased by the fact that during the period of preparation of the customary deep and loose seedbed, fields are extremely vulnerable; and by the fact that even in areas of relatively low annual rainfall, violent rainstorms of high intensity occasionally occur without respect to seasons.

The effect of these soil-conservation practices on machine effectiveness and efficiency is aggravated by the wide equipment used for spraying and harvesting. The loss of accomplishment resulting from point or short rows caused by contour planting is approximately proportional to the operating width of a machine.

Attempts to handle soil conservation by combining terracing with straightline planting across terraces have not been too satisfactory either. Maintaining effective spray application

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Fig. 2 (*Left*) The first step in a 6 to 12-mo program of seedbed preparation, "knocking down" with a string of three tandem-disk harrows • Fig. 3 (*Right*) A three-bed paper layer

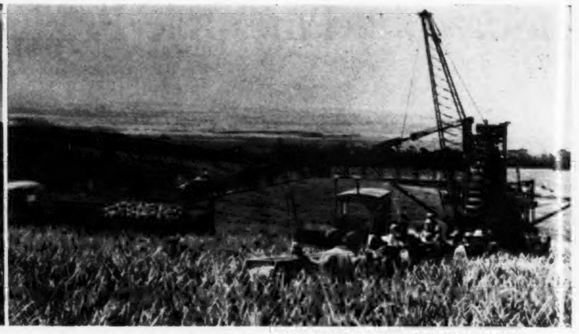

Fig. 4 (*Left*) Spray outfit with two 50-ft booms. This outfit sprays an acre a minute • Fig. 5 (*Right*) Pineapple harvester (loader) with 50-ft conveyor boom

while crossing a terrace at an angle with a 50-ft spray boom at 5 mph is a difficult assignment even for a skilled operator. Also during the rainy season, bad mud holes tend to form where terraces are crossed by field roads.

Non-Scouring Soils. Like many tropical and semitropical soils, most Hawaiian pineapple soils have a high content of colloidal clay. As a result, they are highly adhesive. On the other hand, unless they have been badly puddled by improper handling, they have an excellent crumb structure with the low-shearing strength usually associated with this type of structure. As a result, the soil usually adheres to the working elements of tillage machines and shears within itself. This failure of tillage tools to scour is nearly general throughout the Hawaiian Islands.

All plowing therefore has been done with some type of disk plow, mostly with the heaviest type of five-disk units built on the Pacific Coast. It is entirely impractical to use even the largest moldboard plows of standard type.

Heavy Vegetative Growth. The tillage and seedbed preparation problem is further complicated by the heavy plant growth which must be handled. The green weight per acre is 50 to 100 tons or more, four to eight times that of a good crop of ensilage corn. This material consists of rather solid stems or stumps, of 2 to 3-in diameter and 8 to 12 in long and of very fibrous leaves. This material has been rather aptly described as stove wood tied up with rope.

Several special machines have been built to handle this crop-residue situation, but to date the most common implements used are heavy disk harrows and a special heavy harrow with flat disks known as a stump cutter.

As a result of the problems of crop residue and of non-scouring soil, seedbed preparation is an expensive, tedious program involving four to twelve months. The land is worked an average of over 10 times with disk harrows and plows, using more than 1,000 dhp-hr and over 20 man-hours per acre.

A One-Crop Agriculture. Since no other crop has been found that will yield anything like equivalent returns from the particular Hawaiian soils available for pineapple culture, pineapple production tends to be a one-crop agriculture. As a result, intensive fertilization and soil fumigation, with attendant equipment problems, are essential operations. Soil fumigation is more of a problem than with mainland crops because it usually is combined with initial fertilizer applications and paper laying, which often involves non-uniform operating speed and frequent stops. The soil-fumigation problem has been well presented by Owen in AGRICULTURAL ENGINEERING for October, 1948 (page 435.)

Mulch Paper. The use of mulch paper, which serves to control weeds and to modify temperature and moisture conditions and possibly to improve the effectiveness of soil fumigation, has been found so beneficial that it is a universal practice. Paper, 32 to 36 in wide, is laid 56 to 60 in on centers. A row of plants is planted through the paper about 6 in from each edge. The laying of mulch paper requires special equipment. It also greatly complicates the problem of designing a successful planting machine.

Basically, paper-laying machines are rather simple devices. All are built locally. However, when made to lay three strips of paper at a time, as well as to deposit fertilizer and inject soil fumigant in two lines under each strip of paper, these outfits definitely lose their claim to simplicity.

Planting Material. The operation of planting is further complicated by the weight, bulk, and character of the vegetative planting material used. Major mainland crops, such as corn and cotton, require only a few pounds of seed per acre; and small grains, at most, a few bushels. Enough tomato plants for an acre can be carried in a bushel basket. But the 17,000 to 18,000 planting pieces required for an acre of pineapples weigh 4 to 6 tons. Because of their stiff bristling leaves, these plants occupy 1,500 to 2,000 cu ft. Supplying this volume and weight of plants to a planting machine is a difficult problem which has seriously handicapped the development of planting equipment.

Field Roads. To obtain maximum yields, pineapples are planted so close, 17,000 to 18,000 to the acre, that the ground area is completely shaded relatively early in the production cycle. As a result, it is impractical to operate heavy equipment, such as truck spraying outfits, harvesters (loaders), and fruit-hauling trucks, between the rows. To meet this situation, a system of field roads just wide enough for truck operation has been developed. These roads are spaced approximately 100 ft apart and parallel to the plant rows. Major operating machines have 50-ft booms which extend out from the roads. On relatively level land, the roads are laid out on a rectangular basis with uniform spacing. In contour planting, the 100-ft distance becomes the maximum spacing.

Spraying. The major spraying operations are carried out with large spray units operating from these field roads. The spray outfits are mounted on heavy trucks and have 800 to 1,200-gal tanks and 50-ft booms. For less critical spraying operations, some units are being built with two 50-ft booms. At 5 mph one of these double units sprays at the rate of an acre a minute while in actual operation.

High-Clearance Tractors. High-clearance tractors are used for between-the-row weed-spray application and for applying dry fertilizer in the lower leaf axils. For younger plantings, standard row-crop tractors with widely-spaced front wheels are often used. However, for older plants, these tractors are raised by plantation or local custom shops to give 42-in clearance.

Harvesting. As with spraying, harvesting equipment is operated on the field roads. So-called harvesters are really loaders with 50-ft conveyor booms that reach halfway across the blocks between roads. These machines are similar to the lettuce harvesters used in the Salinas Valley of California.

The cost of harvesting is greatly increased by the fact that not all fruit in a given field will ripen at the same time. This may necessitate going over the field several times, depending on many factors.

The design of fruit-handling equipment is also limited by the fact that a pineapple is cylindrical in shape and cannot be depended upon to roll or not to roll.

Large Capacity Sprinkler Irrigation

By Ernest L. Munter

MEMBER A.S.A.E.

THE William Gehring Farms on which I am employed as agricultural engineer, are located 90 miles southeast of Chicago in Indiana. The chief crops consist of spearmint, peppermint, potatoes, and onions. A large portion of the soil is muck. All of the soil under cultivation has controlled drainage, some to the extent that we are able to use the tile drainage system as a means of subirrigation. The water table under the muck soils can be controlled closely enough so that a good crop can be grown under rather adverse conditions of rainfall.

In order to keep diseases to a minimum and produce a high-quality and high-yielding crop, it has been found desirable to use a rather extensive rotation program. As the muck soils were being developed over the past years, it was possible to put newly developed land into crops. This in part took care of rotation needs. Since this is now no longer possible, it is necessary to resort to other methods.

In this same general area, bordering many of the muck areas are mineral soils of sandy silt loam. This soil is highly productive if properly drained, fertilized, and supplied with sufficient water. The mineral soils are slightly rolling and have some low pockets or depressions. This means that flood irrigation or subirrigation would not be practical.

After considerable investigation and consideration, we decided to plant about 900 acres of potatoes on mineral soil and use supplemental irrigation throughout the growing season, applied by large-capacity, revolving overhead sprinklers.

Many factors were considered in deciding on the type of irrigation system to use. We required a flexible system to suit the many varied sizes and shapes of fields and different sources of water supply, one that would operate effectively on rolling ground and on which we could control the rate and amount of water added to a field. It called for one that could be operated day and night with a minimum amount of labor, and that was simple and easy to operate so as to utilize unskilled or inexperienced labor. A large capacity system was required so as to handle a large acreage. Also it was necessary to keep our investment down within reason. We thought a system of quick-coupling, portable pipe with large-capacity rotating sprinkler heads would best meet these requirements.

Maps were drawn of the various fields to be irrigated, and these showed the location of the source of irrigation water and the general size and shape of the field. By careful study and planning a system and procedure of irrigation was arrived at for each field. From a study of all these plans we arrived at the amount of irrigating equipment we would have to purchase.

In order to effectively irrigate our acreage, six complete irrigating systems were purchased. Each system averaged enough equipment to cover approximately 67 acres per pump setting.

The drainage ditches which border our fields on one, two, or three sides provide a source of irrigation water. By means of control dams we are able to keep a good supply of water in the ditches. Deep wells have been drilled at strategic locations so as to pump into the drainage ditches and help maintain the water supply in times of prolong drought.

Fig. 1 shows the mobile power and pumping unit we used. The pump is a horizontal, split case, double-suction type. It has a bronze impeller, anti-friction bearings, and 6-in suction and discharge. At 1800 rpm it is capable of delivering 1000 to 1100 gpm at 140 psi. The pump is driven by a direct coupling to a six-cylinder, 602-cu-in-displacement gasoline motor. The motor has a maximum rating of 150 hp at 1800 rpm or 115 hp under continuous operation. About 11 to 12 gal of gasoline are required per hour of operation. The motor is equiped with exhaust prime, an electric starter, low oil pressure, and high water temperature switches, thus eliminating the necessity of a man at the motor once irrigation is started. The pump motor and a 275-gal gasoline tank were mounted on a trailer by the manufacturer per our specifications. The trailer has four dual wheels with 7.50x20 tires. This wheel equipment makes it easy to transport the unit over loose soft soils and near ditch banks. A fifth-wheel type of steering is used to enable us to make sharp turns and provide good trailing. The front axle is supported on a rocker pin to give flexibility without frame distortion. The pump is mounted low on the frame to keep the suction head to a minimum.

We used 6-in galvanized steel suction pipe with bolted flanged joints. Rubber gaskets are used to make the joints tight. A large horizontal screen, about 40 in long and of 11-in diameter, provides a suction inlet area of 7 sq ft. The lower one-third of the circumference of the screen is covered with metal to eliminate sucking up silt and sand from the bottom of the ditch.

The water leaves the pump through a 6-in gate valve and a pump-to-line fitting into a 8-in, 18-gage galvanized steel pipe of lap-welded construction. To the body of the pipe is welded a 14-gage coupling and sleeve. The sleeve is beaded and hemmed to give added strength to the male end of the pipe. A rubber gasket is used to form the seal between pipes and handles are provided to carry the pipe. The couplings are flexible and provide for 9 to 11 deg misalignment, making the setup adaptable to level or rolling ground.

Fig. 2 is a schematic representation of our irrigation system. You will note that 8x8x6x6-in crosses are used along the main at 180-ft spacing. These crosses are used to divert the flow of water from the main to the 6-in steel laterals. A butterfly-type valve is installed in the 6-in outlet of the cross. These valves control and direct the flow of water. The valves had a tendency to leak under high pressure. This made it necessary to use an end cap with relief valve over the cross outlets not in use. When it was necessary to remove the end cap, the relief valve relieved the pressure inside. After the first 100 ft of main, a cross, an 8-in valve, and the lateral with sprinkler heads were assembled, the 8-in valve in the main was closed and irrigation started immediately. While irrigating this first setting, the remainder of the main line and a second lateral were assembled. The second lateral is installed directly opposite the first. After the required irrigating time is up, the valves in the crosses are manipulated so as to divert the water to the second lateral. While irrigating from the second lateral, the first one is moved down to the next cross. This procedure is continued until the entire area is covered. It is not necessary to shut down the pump at any time while changing the laterals.

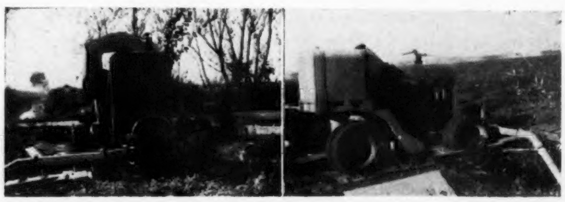

Fig. 1 Two views of the mobile power and pumping unit used on the Wm. Gehring farms

Fig. 3 is a schematic sketch of the riser stand and sprinkler head which we used. We maintained a minimum pressure of 90 psi on the last head in a lateral and more generally 100 psi. When operat-

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1948, as a contribution of the Soil and Water Division.

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ing at 100 psi, the sprinkler manufacturer specifies that each head will deliver 268 gpm with the nozzles as shown, and give a maximum coverage 336 ft in diameter. A speed adjustment controls the rate of rotation from one revolution in 4 min to one revolution in 40 min.

The tripod type of stand with telescoping legs enable us to keep the heads level or tilt them in any direction desired. Being able to tilt a sprinkler head of the large-capacity type under windy conditions will help to compensate for some of the effect the wind has on the spray. The large nozzles operating under high pressure have no tendency to plug. The gate valve is used to stop the flow to any one head independent of the others. This has been advantageous under some of our conditions where we may be irrigating a large field which has some low or wet spots. The heads which cover these spots can be shut off as we progress across a field without disturbing any part of the general system. The valve is also handy when it is necessary to exchange or repair a head while irrigating. Each riser stand is provided with an adapter for a pressure gage so pressure readings at any head can be taken.

In irrigating potatoes, the mains are laid in the direction of the rows and the laterals across the rows. This makes it easier to carry the lateral from cross to cross. Only one size of lateral and main are used to avoid any mixup in setting up the system.

The following cost data, determined from last season's operation, are typical of any one of our six irrigating units; the fixed cost was determined from an average cost of the six units, which is sufficient equipment to cover 67 acres at one pump setting:

Acres irrigated	67
Inches of water per irrigation	1.5
Pump capacity, gpm	1000
Operating pressure at pump, psi	140
Area covered per lateral, acres	3.35
Time between lateral moves, hours	2.25
Rate of application, in per hr	⅔
Operating time per irrigation, hrs	45
Men required to operate system	3
Man-hours required to install pump and main	20
Labor costs, cents per hour	.80
Power cost per hour (fuel, oil, repairs)	$2.50
Estimated life of equipment, years	10
Operating costs:	
Labor (3 x 45 + 20) 80	$124.00
Power 45 x 2.50	112.50
Total operating cost	$236.50
Operating cost per acre-inch of water	$ 2.35
Fixed cost (annual)	
Depreciation at 10 per cent of $10,000.00	$1000.00
Interest, 5 per cent of average value	250.00
Total fixed cost	$1250.00
Fixed cost per acre (180 acres irrigated per system with 2 crews)	$ 6.95
Original investment per acre irrigated	$55.55

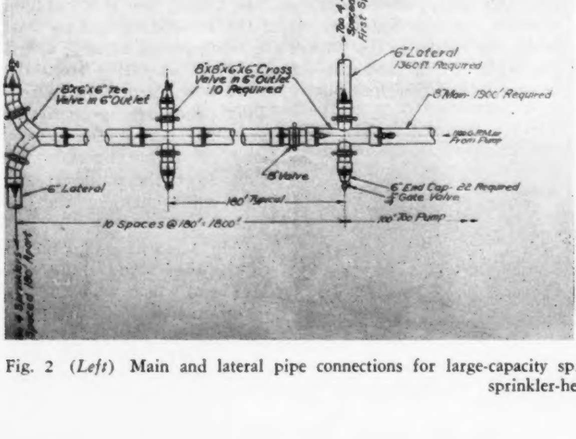
It is difficult to arrive at an annual cost per acre irrigated, as it will vary with the number of irrigations per season, which in turn depends on the amount and distribution of the rainfall. I think there will be very few seasons where less than three irrigations of 1½ in each will be used and more generally five. On the basis of five irrigations per season of 1½ in each the annual cost per acre irrigated would be about $24.58. The cost per acre-inch of water would be about $3.28. In arriving at a more accurate cost we should consider the use of wagons and tractors used to move the pipe between different fields.

Last season we did not have check plots or a method whereby we could actually evaluate the benefit in dollars and cents derived from irrigation. From our own observations we are convinced that the cost of irrigation was well repaid. Some of the highest yields of potatoes ever produced on the farm were produced on mineral and muck soil under irrigation. The quality of the potatoes was far above average.

A portable irrigation system is comparable to a farm machine. Once you have a system readily available you will find ways of putting it to new, beneficial uses. Sprinkling will be used this season to help retard frost and wind erosion in our onion fields and some early potatoes. Last season we derived great benefits from our irrigation system in transplanting peppermint plants. We had an unusually dry May, so we irrigated our muck soil immediately after setting out the plants. This gave the plants a good start and resulted in a very good stand. Very early in April we irrigated the peppermint field from which the transplants were obtained. This forced the plants to a quick, early, vigorous growth. Our muck crops are able to withstand dry periods much better than the same crops grown on upland due to our water-control system. There are very few seasons when large increases in yields could not be obtained on muck soils by water applied at the right time.

It is a general practice to cut a second crop of mint in those fields which will not have mint the following year. We believe that a good irrigation following the first harvest, along with fertilization, will get the second growth off to a good start. We plan on experimenting with the addition of nitrate fertilizer through our irrigation system this season and are hoping that a method will some day be worked out whereby we can irrigate, fertilize, and apply insecticides and fungicides all in one operation.

In conclusion I wish to make the following observations regarding large-capacity overhead irrigation; with only one year's operating experience, my ob- (Continued on page 342)



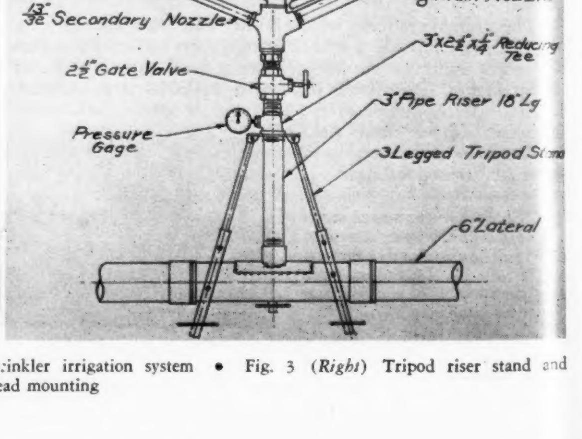


Fig. 2 (*Left*) Main and lateral pipe connections for large-capacity sprinkler irrigation system • Fig. 3 (*Right*) Tripod riser stand and sprinkler-head mounting

Testing Electrical Products for Farm Use

By R. H. Wileman
MEMBER A.S.A.E.

ELECTRICAL products for farm use must meet requirements which may be of but minor importance in other fields. Some of these requirements are (1) wide variations in climatic conditions, (2) topography, (3) size of farm unit, (4) type of farming, (5) board of health and other regulations on products marketed, and (6) remoteness of service when electrical devices fail.

How well the designer and manufacturer have produced a piece of equipment which will properly perform its intended functions and meet these variables, determines its value. Naturally the labor involved and the cost of operation are important factors.

If we select one item of equipment we will undoubtedly find several makes having variations in design and construction and often in principles of operation. Then the question is which ones will most adequately meet farm requirements, give the longest trouble-free service, require a minimum of time and labor to operate, and perform economically. The answers to these questions in many cases involve numerous requirements and conditions not easily determined.

The United Cooperatives Laboratory at Ithaca, N. Y., was established at the request of farmers to aid them in securing quality farm supplies which will better meet their needs and requirements. Thus the major objective of the Laboratory is to obtain these answers.

We normally approach these problems from three directions. First, we collect information pertaining to the function, operation, and requirements of an item, as well as any test data which may be available. The colleges, power companies, and manufacturers have been very helpful in this effort.

Second, we determine from our farmer council how they actually use the equipment, what they expect of it, and their likes, dislikes, and suggestions for improving similar equipment which they may have on their farms. This farmer council is made up of 85 hand-picked farmers located in twelve states. The answers given by this group are not necessarily their own opinions, but often the results of discussions at Grange and Farm Bureau meetings or with neighbors. These farmers also aid in the field testing of new equipment.

Third, we make laboratory checks of construction and tests of operation and performance.

The combination of information thus secured is then used as a basis for specifications for the item under consideration. These specifications are then used by the buyers in securing satisfactory equipment, and in working with the manufacturer to improve the equipment to better meet the needs and requirements of the farm. We have found manufacturers very willing and anxious to cooperate toward this end.

Following is a brief discussion of some of the findings resulting from such test and development projects:

Clothes Washers. This test involved seven well-known makes of conventional agitator-type washing machines. The information presented by P. B. Potter in Virginia Polytechnic Institute Bulletin 361, "Home Laundry Investigations," was used as a guide and background. From this we started in by studying the construction of various machines as to their probable life, serviceability, and general requirements. Arrangements were then made with eight farm housewives to use each of the washers for a period of two weeks in their own homes. Their reactions to various features which affect the operation and work of the machines were recorded on sheets furnished them. This was followed by a wash day at the Laboratory, during which the eight housewives and Laboratory personnel operated and studied the machines simultaneously. As a result several conclusions were reached:

1 The water, clothes, and soap action are materially affected by the shape and style of the agitator. Agitator fins which extend to or near the water line tend to tangle and cause excessive wear on the clothes. With certain designs the soap accumulates as suds on the surface rather than mixing through the water and clothes being washed. The shape of the tub can materially affect clothes and water action.

2 Wringer drainboards with flared sides are much preferred to more flat designs. The position of the inner edge of the drainboard with respect to wringer roll is important. From $\frac{1}{2}$ to $\frac{5}{8}$ in space between the inner edge of the drainboard and the roll gave best results. This same inner edge should be from $\frac{5}{8}$ to $\frac{7}{8}$ in below the top of the lower roll. Spacings other than these resulted in excessive wrapping and wedging of clothes between the roll and drainboard.

3 Control handles should be readily accessible and large enough to be easily grasped with wet soapy hands.

4 A screen over the tub drain is a must. It should be large enough to allow rapid flow, yet have holes not larger than $\frac{1}{4}$ in diameter.

Combined with good mechanical construction, these and other features result in a washer which does a better job and is easier to operate with better satisfaction resulting.

FM Radio Receivers. The FM radio is a relatively new development. Naturally the major demand and sales are in urban areas and apparently the FM receivers were designed for urban conditions. Since FM is primarily a line-of-sight proposition, the remoteness of many farms to the broadcasting stations and rolling topography are major factors in good reception.

Tests of sixteen makes of FM receivers resulted in the finding that none of them could be generally recommended for farm service. This meant that a receiver had to be developed to meet the requirements which farm use presents. Market reports, weather reports, spraying recommendations, etc., are today a part of the farming operation and good radio reception is important. After many tests over a wide range of topographic and other conditions, specifications were set up covering a farm FM receiver. These specifications were then taken to a radio manufacturer who is now producing a set to meet these farm conditions.

To accomplish this end it was necessary to (1) increase the sensitivity of the set so it would satisfactorily pick up weaker signals, (2) have better selectivity to enable station separation, and (3) reduce drift to a minimum. To accomplish this meant major changes in the set, the use of component parts with closer tolerances, and rearrangement of parts.

It was also necessary to develop a new non-directional antenna which would give a high gain. This antenna is of the turnstile type and is available with either one or two bays. The second bay is added in difficult conditions, usually topographic, to give a stronger signal at the receiver.

Electric Brooders. Another product on which we are still working is the electric chick brooder. When we started this test, available information as to what the conditions should be under a brooder for best results was quite conflicting. In general, however, it was indicated that the temperature should be relatively uniform.

Consequently twelve makes of electric brooders were secured. These twelve brooders represented a wide variety of hover styles, types, and locations of heating elements, ventilation principles, etc. So-called "dry runs" were made with each brooder to determine what conditions actually did exist under the various units. With the brooders operating at a room temperature of from 25 to 35 F, the actual temperatures which occurred $2\frac{1}{2}$ in above the litter at eleven different lo-

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1948, as a contribution of the Rural Electric Division.

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cations under the hovers were determined. The range of temperatures at any one time as well as the cycling range were recorded.

It was found that the brooder with the minimum range at any one time gave a variation of 10 F, while the brooder having the maximum range showed a difference of 60 F. The temperature differential at any given point due to cycling also varied materially. The minimum cycling range was 5 F, while 35 F was the maximum.

Smoke tests were made to determine the effectiveness of the various ventilation systems. Marked stratification was found with gravity ventilation. Anything might happen with fan ventilation, depending upon the ability of the fan to move air and the baffling effects which were present.

With this information at hand we selected four of the twelve brooders for an actual brooding test. Those selected were (1) the brooder with the most even hover temperature, (2) the brooder with the widest variation in hover temperatures, and (3 and 4) two in-betweens to give as wide a variation of various factors as possible such as ventilation, heating element location, etc.

On March 9, 1948, 364 day-old chicks were placed under each brooder. Close observations were made of apparent chick comfort and behavior. Checks on feed consumption, growth, and moisture conditions both under and outside the hover were made.

WHAT DID THE CHICKS PREFER?

What did the chicks tell us they preferred? Contrary to expectations, the chicks under the brooder with the wide temperature range (75 to 135 F) showed the greatest activity, ate the most feed, and produced the most rapid gains. This unit required the least attention as far as the thermostat adjustment was concerned. The chicks adjusted themselves to the temperature they desired. The only changes made in thermostat setting of this brooder were those to gradually reduce the temperatures as the chicks became older. The ventilation in this unit was not the best nor was its canopy large enough to accommodate 360 chicks after four weeks. However, from the management standpoint, apparent chick comfort, and activity, it was outstanding.

Using this information, together with observations on ventilation and what the farmer council members told us they wanted in a brooder, a unit was built, endeavoring to incorporate as many of the desired features as possible. Several test brooders of this design are now being built and will be given comparative tests in different sections of the country by universities and poultrymen during the coming brooding season.

Electric Fence Controllers. In studying and testing electric fence controllers, their safety is of the first importance. Compliance with the requirements of the Industrial Commission of Wisconsin were carefully checked.

In comparing 24 makes and models of fence controllers, it was found that in most cases the same circuit design and similar component parts were used. On the other hand, a study of service records on 5,000 fence controllers pointed out the need for improvement in the design of certain component parts. Careful study of these records pointed to definite points of weakness. Attacking these weaknesses in cooperation with a manufacturer, the following improvements were made: (1) Better bearings in the momentum wheel, (2) the use of a better type rectifier, which eliminated the need for the electrolytic condenser which has been one of the weak points, (3) an improved case to better protect the unit, and (4) last, but not least, the use of a vacuum tube in the highline of the secondary of the transformer to ground eliminates the possibility of a steady current flow to the fence in case the contact points become frozen. This is an added safety feature which is important in 110 v, a-c units.

Other electrical equipment which we have worked on, includes automatic electric storage water heaters, farm air compressors, and farm milk coolers. The work on milk coolers is ably presented in an article by R. C. Shipman, titled "Types of Farm Milk Coolers" which appears in the 21st annual report of the New York State Milk Sanitarians, 1947.

It is our belief that this type of work, coordinated with the results of college research and the cooperation of manufacturers, can do much to improve the quality and usefulness of products for farm use.

Sprinkler Irrigation

(Continued from page 340)

servations can in no way be considered conclusive or authoritative.

1 It is important to select proper pump and engine to meet all operating conditions imposed by the sprinkler system. High pressure at the heads (90 to 100 psi) is required to get a good, even, atomized, fog-like application. The manufacturer of our pump loaned us one of their standard production pumping units until they could make delivery of the one we specified. This unit delivered 1000 gpm at 120 psi The results with this unit were discouraging in that it did not have ample power and capacity to maintain the desired pressure.

2 It is important to develop pressure as rapidly as possible and stop the flow rapidly so as to eliminate damage to crops caused from larger droplets of water coming from a sprinkler when the pressure is reduced.

3 The pipe, couplings, and fittings must be strong enough to withstand 140 psi operating pressure plus a certain amount of shock load. The manufacturer of the pipe we use has cooperated with us very closely in meeting these requirements. They have started manufacturing what they call a high-pressure coupling made of 12-gage rather than 14-gage steel. This coupling will be sold to operators requiring high-pressure and large-capacity systems.

4 The sprinkler heads should have a wide range of adjustment as to rate of rotation. We found it desirable to have the heads rotate about one revolution per minute when irrigating certain crops. This faster rotation was obtained by using a special secondary nozzle with the hole drilled at a 7 deg angle.

5 A well-planned procedure of irrigation should be worked out and drawn up for each field prior to irrigation. This greatly increases the efficiency and assures a better job of irrigating.

6 There is a very decided change in the pattern and diameter of coverage under different wind velocities. In some cases we reduced the pressure head and lateral spacing to allow for this.

7 Large-capacity sprinklers will not cover corners or small irregular fields as efficiently as smaller sprinklers.

8 There is a definite need for a good, light-weight, portable irrigation valve for high capacities and pressures. Valves were one of our most troublesome items. Our plans for the 1949 season are to incorporate gate valves in the 6-in cross outlets and eliminate the butterfly valves, end caps, and relief valves. Gate valves have one main objection, which is their weight.

9 Much time is required to couple and uncouple a suction line each time a pump is reset. This will be eliminated this season by a street ell inlet into the suction side of the pump, which will enable us to raise the suction line completely assembled by a boom and hoist attached to the pumping unit trailer.

10 More data is required to arrive at the efficiency of water application of a system in order to determine the gross amount of water required for each irrigation. Such factors as interception and evaporation losses under various temperatures, relative humidity, and wind velocities for various sprinkler rates of application have not yet been determined, according to my knowledge.

11 Hour meters are desirable on pumping units where several units of the same kind are used so as to enable proper preventive maintenance.

12 Much hard labor is required to load and unload the pipe, fittings, and heads. Specially designed transport trailers will greatly facilitate these operations.

The 1949 A.S.A.E. Gold Medalists

The American Society of Agricultural Engineers awarded the John Deere Medal to Dr. H. H. Bennett and the Cyrus Hall McCormick Medal to Dr. E. G. McKibben on the occasion of its annual dinner on June 22, held at East Lansing, Mich.

E. G. MCKIBBEN H. H. BENNETT

CHOSEN by the Jury of Awards of the American Society of Agricultural Engineers to receive the Cyrus Hall McCormick Gold Medal for 1949 is Dr. E. G. McKibben, head of the agricultural engineering department of the Pineapple Research Institute, Honolulu, T. H. With a record of distinction in administration and instruction as well as in research, he may well be thrice qualified for his high honor.

Eugene George McKibben was born December 17, 1895, at Almyra, Arkansas. Here, on a rice farm, he began his boyhood. His parents, Frank and Dora McKibben, were natives of Marshall County, Iowa, and resumed residence there for a time, during which Gene attended the Marshalltown High School. Upon graduation in 1916 he entered Iowa State College as a student in agricultural engineering.

World War I intervened, and for two years following June of 1917 he was in the U. S. Army Ambulance Service, having enlisted in the Iowa State unit shortly after its formation. He served overseas, in Italy, for nearly a year, and in the fall of 1919 resumed his course at Iowa State College. Here, and also in high school, he is recalled by his friends as something of a football player and very much of a wrestler. He competed in the 158-pound class, earned two letters and was big-six champion in his senior year.

As an undergraduate, Dr. McKibben was a member and for two years president of the Adelante fraternity. He also became a member of four honorary scholastic fraternities — Tau Beta Pi, Alpha Zeta, Gamma Sigma Delta, and Phi Kappa Phi — all that were open to agricultural engineering students. One of his friends comments that he was president of just about everything to which he became attached. Among his presidencies, and reflecting one of his major interests, was that of the College YMCA.

It had been his purpose to return to the rice country after graduation and become a good farmer. But when turned out with a bachelor's degree in agriculturing engineering in 1922, he went not to Arkansas but to California, influenced no doubt by the wiles of Leonard J. Fletcher who then headed the division of agricultural engineering in the state university. Serving successively as assistant, instructor, and assistant professor he remained at California for six years. In 1925 he became a member of and a faculty adviser for the newly established chapter of the social fraternity, Alpha Gamma Rho. In 1927 he received his master's degree and was elected to Sigma Xi.

That year also marked the publication, in AGRICULTURAL ENGINEERING, of his first major and still most monumental research series, "The Kinematics *(Continued on page 344)*

IN THE award by the American Society of Agricultural Engineers of the John Deere Gold Medal for 1949 to Hugh Bennett, it goes to a man whose whole life has been one of love for and service to the soil. At the age of eleven, it is told of him, he helped his father mark out lines for the building of field terraces to help in the control of erosion on the Bennett cotton plantation.

Hugh Hammond Bennett was born in 1881 on his father's farm on Gould's Fork Creek, near Wadesboro, North Carolina. That same farm came to be, on August 4, 1937, part of the Brown Creek Soil Conservation District, the first such district to be created in the United States, or in the world. Here he chopped cotton at the age of ten, and here he was cutting cordwood at the age of 16 when, with the assistance of his brother, "Doctor Joe," he entered the University of North Carolina.

On graduation in 1903 (after dropping out of college for two terms) he started as a soil chemist with the Bureau of Soils, U. S. Department of Agriculture. Assigned temporarily to field survey duty, he developed such interest that he asked to be put permanently on the field force. In such survey work in Appomattox County, Virginia, he saw that soil erosion had been a serious land problem earlier than the Civil War. That was in 1904. In 1905 he was directed to survey the soils of Louisa County, also in Virginia, seeking particularly the causes of declining crop yields.

This was the real beginning of a deep-seated interest in processes of soil erosion and its control by Hugh Bennett, which is substantially coincident, if not synonymous, with the origin of modern concepts in soil conservation. He applied the now classic method of comparing soil depths in tilled fields with those in virgin areas, and derived the conviction which has been the driving force of his dynamic life — that loss of soil itself is the greatest of farm problems.

For some twenty years he was as a voice in the wilderness, alarming few other than himself. He wrote articles for both technical and popular journals while pursuing his career as a federal employe. Among the milestones are in 1909 his membership on a committee to report on agricultural potentials in the Canal Zone; in 1914 taking charge of an Alaskan expedition exploring agricultural possibilities in regions contemplated for location of a government railroad; and in 1916 membership on the Chugach National Forest Commission, also in Alaska.

In 1918 it was First Lieutenant Bennett, U. S. Army Engineers. Next year he was a member of the Guatemala-Honduras Boundary Commission. In 1923-24 he served on a Rubber Commission, exploring the possibilities of rubber production in the Americas. In 1925-26, in cooperation with the

Tropical Plant Research Foundation, he made a reconnaissance soil survey in Cuba.

Then came that November day in 1928 when he was asked by a congressional subcommittee to tell the full story of soil erosion — its nature and extent as a problem, and his ideas for its study and attack. An amendment was tacked onto an appropriation bill to start study of erosion and water conservation. The major part of this activity was in charge of Dr. Bennett.

In September of 1933 was launched the Soil Erosion Service. It was frankly regarded by some as a Brobdingnagian boondoggle of U. S. Department of the Interior. Nevertheless, under the direction and drive of Hugh Bennett it made some swift and spectacular moves toward the salvation of soils, and more especially toward awakening of the people.

Two years later came creation of the Soil Conservation Service as a permanent bureau in the Department of Agriculture. Almost as a matter of course, it was at the outset, and still is, headed by Dr. Bennett. In the years of his leadership this Service has grown not only in extent but more especially in esteem, both among the farmers it serves directly and the citizenry at large. In its purity of purpose and probity of practice it is praised by many a critic as having cast off the conventional curse of bureaucracy and become a model for all public servants.

Despite the load that this implies, Dr. Bennett in 1940 served as chairman of the Agriculture and Conservation Section, Eighth American Scientific Congress, and in 1943 was president of the Association of American Geographers. During 1941-42 he headed a mission to Venezuela, sent at request of its government to study and report on its agricultural resources.

As a writer, Dr. Bennett has been prolific and versatile, appealing to popular interest as well as speaking with authority to technical men. His five books all deal with soil and largely with its conservation. His articles, of which more than a hundred are listed, lean still more strongly to soil conservation. Among a half dozen singled out as most noteworthy, the first is "Economics of Preventing Soil Erosion," published in AGRICULTURAL ENGINEERING in the issue for September, 1928 — the eve of his call to conservation as a career.

Despite that augury and his present honor, Hugh Bennett is not a member of the American Society of Agricultural Engineers, nor does he regard himself as an engineer. Neither does he lack for technical and honorary memberships, which include the American Society of Agronomy, American Geographical Society, American Association for the Advancement of Science, American Forestry Association, Association of American Geographers, Friends of the Land, Canadian Conservation Association, Sociedad Geografica de Cuba, Washington Academy of Science, Cosmos Club, and Explorers Club. He was founder of the Soil Conservation Society of America, and is chairman of the Pan-American Soil Conservation Commission.

Among his friends, Hugh Bennett is held in awe for the enormity of his appetite — not only for work, and for learning, and for friendship, but for food, notably oysters by the dozen as preliminary to a real meal. A connoisseur of both hominy grits and lye hominy, he has a special variety of corn he grows in his own garden and prepares it with lye leached from oak and hickory ashes burned at his own hearth. They say he likes good stories and tells them well, even as he has told the story of soil and its conservation.

They rejoice in this, his latest honor. Prior honors, too many to mention, include adoption by the Crow Indian Tribe, the placement of a monument, designating him as the father of soil conservation, by the soil conservation districts of Ohio on the occasion of the state's Second Frontier Day, and the holding of a "Hugh Bennett Day" by the state of North Carolina under sponsorship of his own Brown Creek district. Prior medal awards have come to him from the National Audubon Society, the Garden Club of America, the American Geographical Society, the U. S. Department of Agriculture, and the National Agricultural and Industrial Society of Cuba.

E. G. McKibben — 1949 McCormick Medalist

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and Dynamics of the Wheel-Type Farm Tractor." At the moment it was a question of grim reality, for certain tractors had a fatal tendency to backflop, and it was a matter of life and death to diagnose and correct the cause. Today these McKibben findings are classic. It seems safe to surmise that for twenty years every tractor offered by any responsible company has been checked against Gene's analyses and formulas.

With the opening of the academic year in 1928, Dr. McKibben returned to Iowa State College as associate professor in the department of agricultural engineering headed by Dr. J. B. Davidson. Here he remained for 14 years, less interruptions. One was the summer of 1930, which he devoted to research in field power and machinery at Pennsylvania State College. The other was a period during 1935 and 1936, when he was a research fellow on leave for graduate study.

At the end of that period of study, Iowa State College awarded him the degree of Ph.D. based on a joint major in agricultural engineering and soils, and a minor in mathematics. A part of his work at Iowa was the teaching of dairy engineering, and he is credited with complete reorganization of that course.

In the summer of 1942, Dr. McKibben left Iowa to become professor and head of the department of agricultural engineering at Michigan State College where he re-established the professional curriculum in agricultural engineering. He remained at Michigan State until May of 1945. Meanwhile there were other dovetailed or superimposed assignments. One was with the WPA national research project in 1937, headed by Dr. J. A. Hopkins. In the spring of 1943 he was consultant to the farm machinery division of the War Production Board, and in June, 1945, to the Aberdeen Proving Ground of the War Department. Perhaps it should be included that in 1942 he served on War Price and Rationing Board No. 85-2 at Ames, Iowa.

As befits a man with research instincts, E. G. McKibben has been a consistent but not prolific writer, and particularly consistent in his contributions to AGRICULTURAL ENGINEERING. In a bibliography of 42 titles, 22 of the references are to this publication. Moreover, one title covered seven articles, and another, with co-authors, consisted of ten. Practically all the other titles were in bulletins or other official publications of the colleges where he has served, their allied experiment stations, or agencies of the federal government.

He has proved equally proficient as sole author and as collaborator. In the series of articles, entitled "Transport Wheels for Agricultural Machines," in AGRICULTURAL ENGINEERING, which received one of the ASAE Paper Awards, his name was one of five.

In service to the American Society of Agricultural Engineers, Dr. McKibben has, along the years, acted as member of various committees in the Power and Machinery and College Divisions. He was chairman of the College Division in 1938 and member of its advisory committee for two years prior. In 1938 and 1939 he had charge of a cooperative project on pneumatic tires for agricultural machines. He served on the nominating committee in 1940 and as a member of the Council from 1941 to 1943.

Dr. McKibben's wife is the former Ethel Marie Moorhead, his classmate at Iowa State, whom he married the summer of their graduation. They have three daughters, all grown and two of them married. Always active in the religious side of life, he is presently affiliated with the Central Union Church of Honolulu.

In his professional associations, too, Gene has heard the call of the Islands. He holds membership in the Engineering Association of Hawaii and in the Honolulu Academy of Science. Besides being a fellow of the American Society of Agricultural Engineers, he is a member of the Society of Automotive Engineers.

NEWS SECTION

Frank J. Zink Takes Office as the New ASAE President

FRANK J. ZINK, who took office as the newly elected president of the American Society of Agricultural Engineers on June 22, at the close of the Society's 42nd annual meeting, has been an active member since 1926 and was elected to the grade of Fellow in 1944.

Mr. Zink is a native of Iowa. He was born in Marshall County, and grew up on the farm there which is still held by his family. He attended Marshalltown High School and later graduated in agricultural engineering from Iowa State College in 1924. Following graduation he was employed for five years by the Iowa Engineering Experiment Station as a field engineer working on the promotion and development of rural electrification. He left Iowa in 1929 to engage in rural electrification work throughout the Middle West as an engineer for Westinghouse Electric and Manufacturing Co.

In 1930, Mr. Zink went to Kansas State College as associate professor of agricultural engineering. During the five years he was there, he did original work in moisture studies on hay and grain. He joined the Allis-Chalmers Mfg. Co., in 1935 as research engineer and worked

FRANK J. ZINK

for several years on development of small farm equipment. His work at Allis-Chalmers led to his appointment as director of research of the Farm Equipment Institute in 1941. In this position he not only handled college relations and some government relations in research problems, but in addition served as secretary of the Institute's Advisory Engineering Committee engaged in the power take-off and drawbar safety program that led to the adoption of standardized dimensions and safety devices.

Mr. Zink's wide experience with agricultural engineering problems and his broad acquaintance with leaders in the field led him to establish his own company of consulting engineers, Frank J. Zink Associates, in 1944. He has done an outstanding job in handling special problems for private interests, and in addition he has helped in the organization and direction of two successful trade associations in the farm equipment field. He and his organization likewise have conducted a successful merchandizing operation where agricultural engineering is needed for the distribution of farm equipment in specialized fields.

Throughout his lifetime of activity in agricultural engineering work, Mr. Zink has worked for wider recognition of this field. He has served on many important committees and has taken an active part in Society affairs. He was chairman of the Power and Machinery Division in 1935-36. As a leader in his field, Mr. Zink is called on for frequent meetings and for the writing of many papers and articles on subjects relating to agricultural engineering.

In 1925, Mr. Zink married Mary Hart, a graduate of University of Iowa, and a well-known educator in her own right. They have two daughters, Mary Frances who is graduating this year from Kansas State College and Elizabeth Jean who will graduate from Iowa State College in 1950. Mr. Zink makes his home at Glen Ellyn, Illinois, where he takes part in community activities. His affiliations include, in addition to the American Society of Agricultural Engineers, the American Society for Engineering Education, Society of Automotive Engineers, Union League Club, Glen Oak Country Club, Apha Zeta, and the Episcopal Church.

A.S.A.E. Meetings Calendar

September 7 to 9 — NORTH ATLANTIC SECTION, Pennsylvania State College, State College

October 6 to 8 — PACIFIC NORTHWEST SECTION, Harrison Hot Springs Hotel, Harrison Hot Springs, B. C.

December 19 to 21 — WINTER MEETING, Stevens Hotel, Chicago, Ill.

ASAE Annual Meeting Tops 1000 Attendance

A NEW record attendance of over 1000 agricultural engineers and their wives, and children assembled at Michigan State College, East Lansing, June 19 to 23, to share in the technical, professional, and social features of the 42nd annual meeting of the American Society of Agricultural Engineers. New high attendance of regular members, student members, and women and children all contributed to the substantial over-all increase in numbers present.

Michigan and particularly Michigan State College, the industries of the Lansing and Detroit areas, the Michigan Area Section of the Society, and individual members in the area proved thoughtful and gracious hosts in inviting, accommodating, and entertaining their professional associates and their families. Their thoughtfulness ranged all the way from providing excellent conditions for the general and division sessions of the meeting to providing nursery and baby-sitter service for accompanying extremely junior agricultural engineers and their sisters.

Modern materials and equipment for farming, teaching, extension, and research in the new MSC agricultural engineering building provided a distinctly appropriate atmosphere for the technical division sessions held there.

Throughout the arrangements and events of the meeting there was repeated evidence of local public recognition of the importance of agricultural engineering to the agriculture and industry of Michigan.

The distance which agricultural engineering has moved and has yet to move, in space, time, technical progress, and related human welfare, was indicated by Dr. J. B. Davidson, charter member and first president of the Society, reporting informally on his recent experiences in China. This was a feature of the Sunday evening entertainment following a buffet supper.

Prof. C. L. Allen, head of civil engineering, speaking for Lorin G. Miller, MSC dean of engineering, extended the official welcome of the College and State to the Society, at the opening general session, Monday afternoon. In doing so he emphasized that agricultural engineers are accepted at face value and utilized in Michigan as engineers, applying engineering in the interest of agriculture, both directly and through the industries which serve agriculture.

In the president's annual address retiring President Arthur J. Schwantes emphasized the point that farmers are increasing the effectiveness of their operations by increasing application of the data and principles developed by the agricultural and engineering sciences.

"The Engineer as a Citizen" has heavy responsibilities in his own as well as the public interest, to help preserve and improve the social and economic environment most favorable for effective engineering work. Leonard J. Fletcher, director of training and community relations for the Caterpillar Tractor Company, and a past-president of the Society, brought out this point in a challenging address before the opening general session. He indicated that these responsibilities can best be met by engineers taking an intelligent interest in the affairs of their home communities; by promoting understanding of free enterprise and the interdependence of various types of workers in its operation; by exposing the fallacies of isolation, "groupism," and attempts of various groups to gain at the expense of other groups rather than by increasing their own value to the community.

In another general session address, "Farm Buildings — A Forward Look," Henry Giese, professor of agricultural engineering, Iowa State College, challenged the group to further progress in design for functional efficiency as well as structural soundness and economy of materials.

J. C. Dykes, assistant chief, U. S. Soil Conservation Service, drew a sharp picture of the relation between farm equipment and conservation in his address on "Farm Machinery for the Conservation Farmer."

Robert S. Calkins, executive secretary, National Association of Soil Conservation Districts, speaking for Kent Leavitt, who was unable to be present, emphasized the close relation between soil conservation and engineering, and the economic and social strength and well-being of populations.

Unusual interest was shown in the panel discussion "Public Rela-

tions for Agricultural Engineers" presented by four of the younger members of the Society. They were Charles E. Ball, of "Southern Agriculturist"; E. W. Schroeder, Oklahoma, A. & M. College; W. E. McCune, Central Power and Light Co., Corpus Christi, Texas; and J. H. Wessman, International Harvester Co. They brought out a number of ways in which agricultural engineers, individually and collectively, may become better known and better understood; and ways in which being well and favorably known will help improve opportunity for agricultural engineers to work effectively.

A larger proportion than usual of the record meeting attendance (over 800) was present for the Society's annual dinner, and taxed even the excellent facilities of the recently enlarged Student Union building at the College.

Dr. Jorn A. Hannah, president of Michigan State College, made the group feel truly welcome with a short talk emphasizing the position of the College as an educational service unit to the working people of the state and nation; and its appreciation of the importance of agricultural engineering.

Honors and awards presented or cited by President Schwantes following the dinner included the John Deere Medal to Dr. H. H. Bennett, chief of the Soil Conservation Service, U. S. Department of Agriculture; the Cyrus Hall McCormick Medal to Dr. E. G. McKibben, head of the agricultural engineering department, Pineapple Research Institute of Hawaii; ASAE Paper Awards to H. B. Walker, J. W. Simons, Dwight D. Smith, Forrest B. Wright, and S. W. McBirney; ASAE Collegiate Awards to Victor I. Myers, University of Idaho; Donald F. Turner, University of Missouri; L. L. Boyd, Iowa State College; The F.E.I. Student Trophy Award to the South Carolina Student Branch of the Society, and life memberships in the Society to J. W. Carpenter, E. B. Doran, O. W. Israelsen, Geo. W. Kable, R. W. Trullinger, and Hall B. White.

Following these awards retiring President Schwantes formally turned over the duties, honors, and official gavel of the office to incoming President Frank J. Zink. President Zink, in his first official act, presented a past-president's pin to Mr. Schwantes.

In his annual dinner address on "American Know-How Around the World," John Strohm, associate Editor, Country Gentleman, showed in a frequently humorous report on his travels that the working people of Russia and other parts of Europe and the Middle East are weary of the burdens of war and hopeful for a real and enduring peace. He reviewed in pictures and narrative several instances in which American technical and economic help is removing causes of war, improving living conditions, and helping people to understand the American interpretation of democracy.

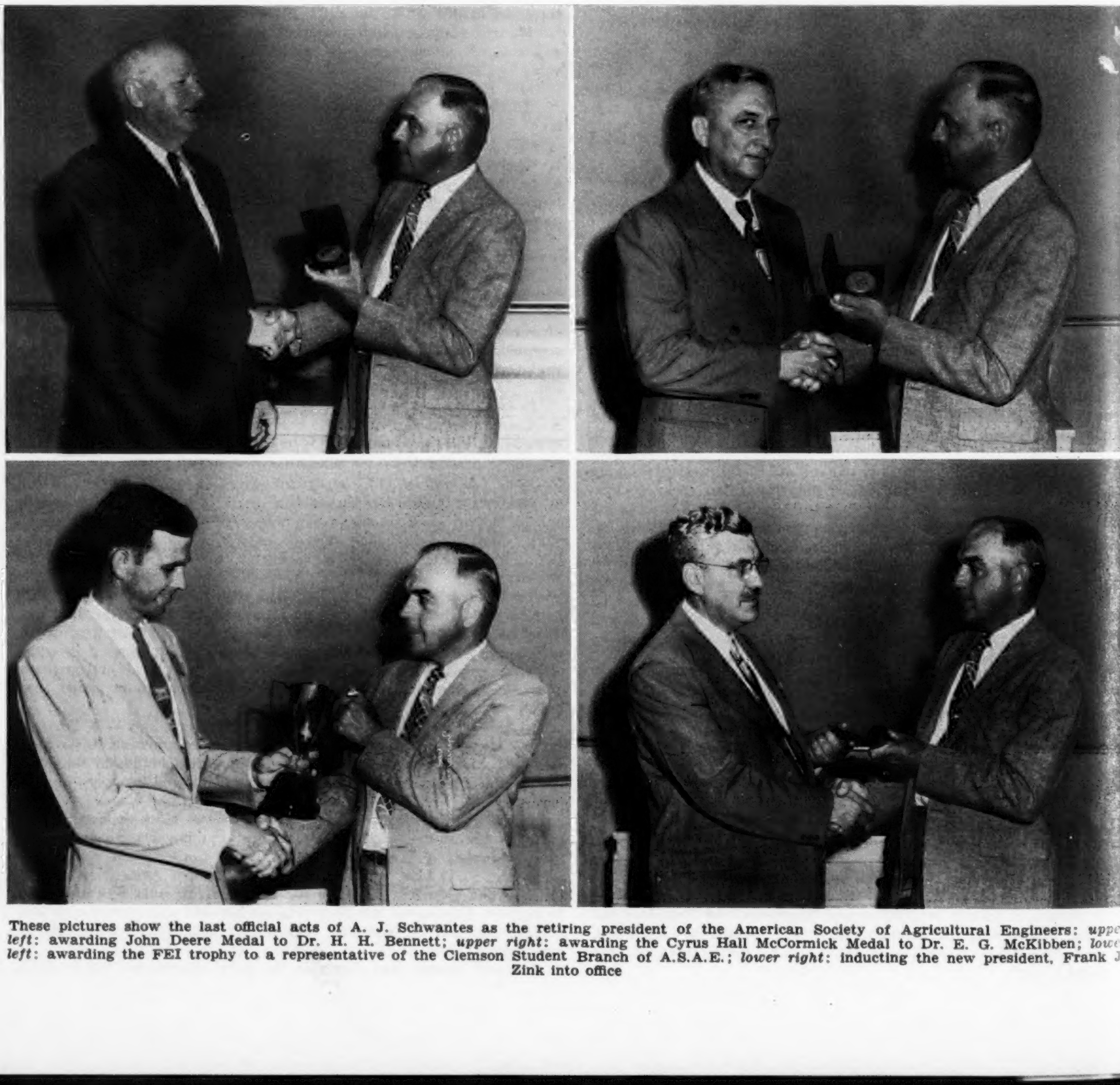
A chicken barbecue followed by a square dance on Tuesday evening proved a popular entertainment feature.

Local trips, demonstrations, and exhibits measured up to a high standard of interest value and were generally well attended. They included rural fire-fighting demonstrations, spraying and dusting demonstrations, and trips around the campus and to industries in the Lansing area.

The importance and successful means of getting agricultural engineering progress applied in actual farm practice were well brought out by the program and numerous exhibits sponsored by the Society's Committee on Extension.

Numerous favorable comments were heard on the programs offered by the various divisions, both as to interest value of the subject matter and the effectiveness with which the various subjects were covered without overrunning planned closing times. Space limitations prevent more adequate reporting of the division programs, but many of the papers will be printed in AGRICULTURAL ENGINEERING or otherwise made available in the next several months.

A full program for the students present was provided by the National Council of Student Branches, the Committee on Student Branches,



These pictures show the last official acts of A. J. Schwantes as the retiring president of the American Society of Agricultural Engineers: *upper left*: awarding John Deere Medal to Dr. H. H. Bennett; *upper right*: awarding the Cyrus Hall McCormick Medal to Dr. E. G. McKibben; *lower left*: awarding the FEI trophy to a representative of the Clemson Student Branch of A.S.A.E.; *lower right*: inducting the new president, Frank J. Zink into office

and the local arrangements group. Features included a discussion of the F.E.I. Award competition, the complimentary dinner provided by the International Harvester Company, consideration of employment opportunities in industry and public service, reports from Student Branches, and discussions of plans for the next school year. The students present also shared in the general sessions, local trips, and entertainment.

Detroit industry's invitation to the Society members to take this opportunity to improve their mutual acquaintance, was accepted by a capacity crowd. Leaving East Lansing at the close of the regular meeting, Thursday afternoon, they banqueted in Detroit in the evening with leaders of the Detroit industries serving agriculture. H. B. Walker introduced the A.S.A.E. group to their hosts with an address picturing the significance and some of the major accomplishments of agricultural engineers. Dr. Charles F. Kettering, president of General Motors Research Corporation, spoke for the host group and expressed their appreciation of the contributions agricultural engineers have made to technical, economic, and social progress. On Friday the visitors were shown through industrial plants of their choice in the Detroit area.

ASAE Paper Awards Announced

H. B. WALKER, J. W. Simons, Dwight D. Smith, Forrest B. Wright, and S. W. McBirney were winners of the five 1949 ASAE Paper Awards made annually by the American Society of Agricultural Engineers, as the authors of the five top-scoring papers published in AGRICULTURAL ENGINEERING during 1948 which were rated by a committee of five judges.

First public announcement of the winners this year was made during the Society's annual meeting at Michigan State College in June.

The winning papers were "A Resume of Sixteen Years of Research in Sugar Beet Mechanization," by H. B. Walker; "Drying Seed Grain with Calcium Chloride," by J. W. Simons; "Design of a Terrace System from Hydrologic Data," by Dwight D. Smith; "A New Automatic Egg Washer and Drier," by Forrest B. Wright; and "The Relation of Planter Development to Sugar Beet Seedling Emergence," by S. W. McBirney.

Honorable mention was given to five additional papers receiving equal ratings just below the top five. They were: Basic Requirements in the Design and Development of the Self-Propelled Combine," by Tom Carroll; "How to Reduce Ear Corn to Bushels of Shelled Corn," by J. L. Schmidt; "The Development of a New Sugar-Beet Harvester," by John B. Powers; "Automatic Watering Systems for Poultry in Winter," by C. N. Turner," and "Spray Painting Farm Metal Roofs," by Charles A. Matthews.

Additional papers rated among the best twenty-five included "A Course in Agricultural Hydrology," by R. K. Dubois; "Improved Designs for Grain Bin Floors," by Gordon L. Nelson; "The Effect of Spillway Storage on the Design of Upstream Reservoirs," by M. M. Culp; "Essential Characteristics of Durable Concrete Drain Tile for Acid Soils," by Dalton G. Miller and Phillip W. Manson; "Registration of Professional Engineers," by A.S.A.E. Committee on Professional Recognition, S. M. Henderson (chairman) and R. K. Frevert; "Types and Performance of Farm Grain Driers," by W. V. Hukill; "Problems of a College Agricultural Engineering Department," by Ray W. Carpenter; "Irrigation of Corn in the Piedmont," by Joe B. Richardson; "Effect of End Flares on Capacity of Irrigation Siphon Tubes," by R. H. Dubois; "Essential Characteristics of Durable Concrete Draintile for Alkali Soils," by Phillip W. Manson and Dalton G. Miller; "The Flow of Water Through Soil," by C. S. Slater; "Problems in the Design of Chemical Weed-Control Equipment for Row Crops," by E. L. Barger, E. V. Collins, R. A. Norton, and J. B. Liljedahl; "The Processing of Sugar Beet Seed," by Roy Bainer; "Analytical Procedures for Determining the Effect of Land Use on Surface Runoff," by W. D. Potter; and "Tillage in Potato Production," by Watson W. Tranter.

Members of the Committee on Paper Awards which did the judging were B. C. Reynolds (chairman), L. A. Jones, J. L. Strahan, W. D. Hemker, P. W. Manson, and L. H. Schoenleber.

U.S. Delegate to International Dairy Congress

ARTHUR W. FARRALL, head, agricultural engineering department, Michigan State College, has been appointed as one of the eleven official delegates from United States to the International Dairy Congress to be held at Stockholm, Sweden, August 15 to 19, 1949, inclusive, according to announcement made recently by the U. S. Department of State.

Mr. Farrall will represent the machinery and equipment phases of the American dairy industry. He will also present two papers before the Congress, and will act as reporter for one of the sections.

While in Europe, Mr. Farrall will visit agricultural engineering institutions in Sweden, Great Britain, Holland, Denmark, and France.

Pringle New Chairman Washington Section

AT THE final meeting of the 1948-49 meeting session of the Washington (DC) Section of the American Society of Agricultural Engineers, held at the USDA Agricultural Research Center at Beltsville, Md., H. S. Pringle, extension rural electrification specialist, Rural Electrification Administration, USDA, was elected the new chairman of the Section for the ensuing year, succeeding H. L. Garver.

The other officers elected at this meeting include a new vice-chairman, John W. Rockey, agricultural engineer, farm buildings and rural housing division, U. S. Department of Agriculture, and as secretary-treasurer, S. J. Marek, Rural Electrification Administration, USDA.

Meeting of KTL at Wiesbaden

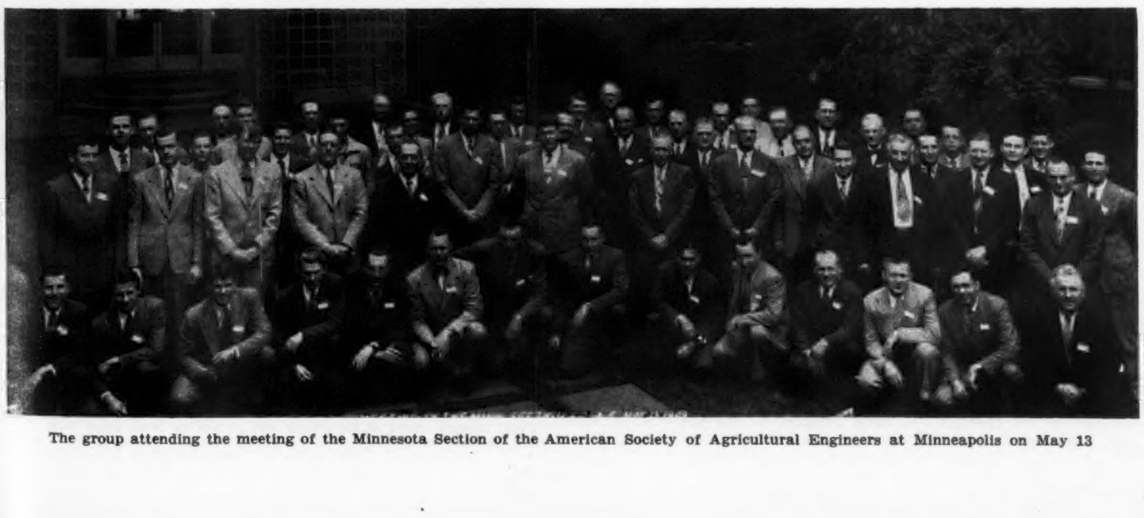
THE Kuratorium fur Technik in der Landwirtschaft (KTL), now at Geesen, 37 Ludwigstrasse, Germany, is the successor of the former Reichskuratorium fur Technick in der Landwirtschaft (RKTL) at Berlin.

The KTL held its first postwar meeting at Wiesbaden from March 8 to March 11, 1949.

Dr. Schlange-Schoningen, minister of agriculture for Western Germany, in an introductory tea reception addressed the representatives of the German daily press and professional publishers. He spoke of the fact that Western Germany lost large farming areas in Eastern Germany where large modern farming machinery was in use and that these areas with their surplus of agricultural products supplied the need of the population of the extensive industrial sections in the western part of Germany. The remaining West is now overpopulated not only in the destroyed cities, but also on the flat land which is crowded with millions of refugees expropriated from foreign countries in the East. Furthermore, Western Germany is a typical land of small peasant farming.

This fact creates a completely new situation for all technical problems in agricultural engineering. Small machines have to be developed in order to help small farmers overcome their daily drudgery according to the motto: It is the purpose of all technical achievements to take drudgery out of life.

At the meeting the problems were discussed in different scientific sections by one or more speakers. They dealt with soil conditions and plowing, harvesting methods, the influence of modern harvesting, transportation and storage problems, construction of farm buildings, small



The group attending the meeting of the Minnesota Section of the American Society of Agricultural Engineers at Minneapolis on May 13

machines for the individual farmer, all-purpose machines and larger machines for community use, conservation of agricultural products and byproducts.

The problems discussed comprised a much wider range than ever before connecting many adjoining branches of research.

The reports characterized the KTL as the spiritual clearing house for agricultural engineering.

Announce New Welding Paper Competition

A SECOND $25,000 agricultural award and scholarship program was recently announced by the James F. Lincoln Arc Welding Foundation.

Awards will be equally divided between two classes of competitors, namely, agricultural producers and persons in agricultural education and services. Eighty-five cash awards totaling $10,000 will be given in each classification for the top 85 entries of papers on the use of arc welding in making, maintaining, or repairing farm machinery, equipment, buildings, or other farm structures. In addition, ten $250 scholarships named for the first ten award winners in each division will be given to the colleges of agriculture in the states of residence of the award winners. The scholarships are to be awarded to individual students by these colleges on the basis of scholastic merit, imagination, and promise, without regard to financial need.

Individual cash awards run from $1500 to $50. The competition is being held open for a year, the closing date being June 15, 1950. Entries by undergraduate students in agriculture or agricultural engineering will be classed in Division I, with those of farmers and members of farm families. Teachers of agriculture in vocational schools, high schools, and colleges; county agents; professional soil conservationists; other specialists; and graduate students in agriculture or agricultural engineering are eligible to compete in Division II. A jury of awards to be drawn from the fields of agriculture and engineering will judge the entries as soon as practicable following the close of the competition, and payment of awards will be made on completion of the judging. A committee on rules including the deans of fifteen colleges of agriculture has approved the rules of the contest.

Further information may be obtained by addressing The Secretary, The James F. Lincoln Arc Welding Foundation, P. O. Box 3728, Cleveland 1, Ohio.

Personals of A.S.A.E. Members

Deane G. Carter, professor of farm structures, and *Ralph C. Hay,* assistant professor of agricultural engineering, University of Illinois, were two of 16 members of the faculty of the college of engineering who were honored recently at a convocation sponsored by the University Technograph and Engineering Council for being elected as the "most effective" teachers in their respective departments of the University.

Robert M. Dill, captain, Quartermaster Corps, U. S. Army, until recently stationed at the headquarters of the Munich (Germany) Military Post, was recently transferred to Pittsburgh where he is pursuing a course in petroleum engineering in the graduate school of the University of Pittsburgh.

Guy F. Gardner has resigned as field and test engineer, Bradley Mfg. Works, to take a position as group engineer in farm machinery design with Harry Ferguson, Inc., Detroit.

M. Dale Gilbert, formerly sales engineer for the Mason City Brick and Tile Co., recently resigned and now holds a similar position with the Ottumwa Brick and Tile Co., Ottumwa, Iowa, and will be engaged in the promotion and sale of brick and building and drain tile.

Earl G. Johnson, on leave from the U. S. Soil Conservation Service, and serving as land reclamation specialist at the general headquarters of the American occupation forces in Japan, reports that Japan has an agricultural engineering society (Nogyo-doboku-Gakkai) established in May, 1929. It has a quarterly publication, and has issued five books pertaining to water conservation, also a handbook of agricultural engineering. There are approximately 20,000 people employed by the Agricultural Land Bureau in land reclamation, irrigation, and drainage work, which is the largest field of agricultural engineering work in that country.

O. H. Lovelace, formerly on the advertising and sales promotion staff of Willys-Overland Export Corp., is now chief testing engineer for the Dearborn Motors Testing Corp. His work will include the testing of all farm implements sold by Dearborn Motors Corp.

John W. Mattingly, formerly sales and service engineer, Automatic Equipment Mfg. Co., is now employed as assistant engineer of the Heath Engineering Co., Fort Collins, Colo. His work will include sales engineering, compilation of instruction books, production coordination, and basic design for farm implements and special flame-cutting tools.

Maurice W. Nixon, recently resigned as a member of the engineering staff of the Hertzler and Zook Division of The Sperry Corp., to take a position of chief field testing engineer for the New Holland Machine Co., at New Holland, Pa., another subsidiary of The Sperry Corp.

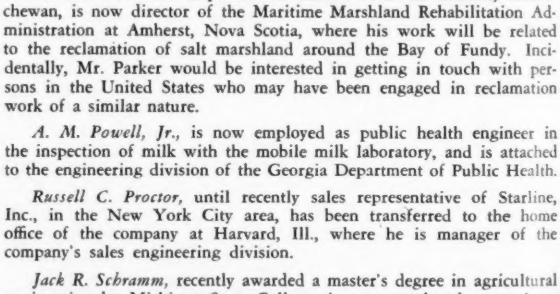
Robert R. Owen has resigned as engineer, California Packing Corp., with which he was engaged in a program for increasing mechanization of pineapple production in Hawaii, to accept a position on the staff of the agricultural products development section of the Grasselli Chemicals Department of the E. I. duPont de Nemours & Co., Wilmington, Del. He will specialize in the agricultural engineering phases of the development work on insecticides, fungicides, and herbicides.

John S. Parker, formerly connected with the Experimental Farm Service of the Dominion Experimental Station at Swift Current, Saskatchewan, is now director of the Maritime Marshland Rehabilitation Administration at Amherst, Nova Scotia, where his work will be related to the reclamation of salt marshland around the Bay of Fundy. Incidentally, Mr. Parker would be interested in getting in touch with persons in the United States who may have been engaged in reclamation work of a similar nature.

A. M. Powell, Jr., is now employed as public health engineer in the inspection of milk with the mobile milk laboratory, and is attached to the engineering division of the Georgia Department of Public Health.

Russell C. Proctor, until recently sales representative of Starline, Inc., in the New York City area, has been transferred to the home office of the company at Harvard, Ill., where he is manager of the company's sales engineering division.

Jack R. Schramm, recently awarded a master's degree in agricultural engineering by Michigan State College, is now employed as engineer in the product engineering department of Dearborn Motors Corp. at Detroit.



This picture is a good example of how engineering can lift the farmer out of the dumps and into the clouds. The float shown was the work of the Mississippi Student Branch of A.S.A.E., and won first prize at the recent Annual Agricultural Day Festival held on the campus of Mississippi State College. The float depicts a decrepit farmer with his worn-out mule, in contrast to modern farming symbolized by the International "Cub" tractor riding in the clouds and driven by Miss Edna Earl Davis. Jack Oakman, a member of the Branch, portrays the part of the farmer

Necrology

RICHARD N. MILLER, senior member of the Washington State College Agricultural Extension Service, passed away at Finch Memorial Hospital, Pullman, Washington, June 3. He had worked at the office, completing arrangements for his part of the state 4-H club camp, but complained of a slight indisposition. He was taken to the hospital late in the afternoon and died a few minutes later of a heart attack. He had suffered from a heart condition for many years. He was born April 28, 1885, in Kirksville, Mo., and came to Washington and graduated from Washington State College in 1908.

Immediately following his graduation, he joined the staff of the Western Washington Experiment Station in Puyallup as assistant horticultural agent. He served as a state inspector in Chehalis from 1909 to 1913 and as assistant agronomist in Woodward, Oklahoma, in 1914. Late in 1914 Miller went to the Extension Service in Pullman where he began the career that gave him friends in every part of the state and made him a national reputation. Under his direction much of the pioneer land clearing work in western Washington was started and carried out. He acquired national reputation as a pioneer in the field of home refrigeration. During World War II, Mr. Miller turned his energies to the field of labor-saving machinery and developed many devices which saved hours of labor for Washington farmers.

He was a member of Sigma Alpha Epsion, Epsilon Sigman Phi, Mu Beta Beta, and the Grange. He is survived by a son and daughter-in-law, Mr. and Mrs. Richard N. Miller, Jr., Fairlawn, N. J., and a sister Miss June Miller who was living with him at their home 1707 B street in Pullman.

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Clifton E. Alexander, Jr.—Rural service engineer, Alabama Power Co., Mobile, Ala.

Bruce R. Anderson—Weston, Mich.

S. O. Barefoot—Manager trainee, Guilford F. C. X., 120 Lewis St., Greensboro, N. C.

Bill E. Berry—Graduate fellow in agricultural engineering, University of Idaho, Moscow, Ida. (Mail) 226½ East D St.

Robert L. Boettcher—R. R. No. 1, Box 212, Vancouver, Wash.

Arlen D. Brown—Instructor in agricutural engineering, Purdue University, Lafayette, Ind.

Julian Bulanadi—Agricultural engineering div., Bureau of Plant Industry, Manila, Philippines.

John C. Campbell—Rural housing specialist, Extension Service, USDA. (Mail) Agricultural Engineering Bldg., Oregon State College, Corvallis, Ore.

Frank O. Coppedge—R. R. No. 4, Brownsville, Tenn.

V. B. Coxworth—Research engineer, Massey-Harris Co., Ltd., Toronto 1, Ont., Canada.

Harold O. Crowell—Acting head, rural engineering section, New York State A. and T. Institute, Alfred, N. Y. (Mail) Box 751.

Thomas H. Curtis—Agricultural engineer, Soil Conservation, Service, USDA. (Mail) Choteau, Mont.

Wayne W. Ducommon—Engineer, flood control, Soil Conservation Service, USDA. (Mail) 1525 W. Palmer, Sioux City, Iowa.

Victor C. Fuhrwerk—Instructor in agricultural engineering, Iowa State College, Ames, Iowa. (Mail) 146 Hyland.

George B. Hanna—Graduate student in agricultural engineering, Iowa State College, Ames, Iowa.

Keith W. Hardy—Assistant in agricultural engineering, Purdue University, Lafayette, Ind.

R. H. L. de S Illesinghe—Assistant engineer, irrigation dept., Government of Ceylon, 36 Arethusa Rd., Colombo 6, Ceylon.

John R. Jaquish—Rural representative, Northern Pennsylvania Power Co. (Mail) 17 Main St., Towanda, Pa.

Benjamin A. Jones, Jr.—Graduate assistant in agricultural engineering, University of Illinois. (Mail) 306 E. Armory Ave., Champaign, Ill.

Howard Keck—2451 17th Ave., San Francisco 16, Calif.

Donald R. Kendall—South Woodstock, Vt.

Harold L. Kugler—Associate professor of agricultural engineering, Kansas State College, Manhattan, Kans.

Howard A. Lamb—Bassett, Nebr.

Crispin R. LasMarias—Instructor in agricultural engineering, University of Philippines, College, Laguna, Philippines.

Bruce H. Lundgren—Section engineer, hydraulic div., Sundstrand Machine Tool Co., Rockford, Ill.

Maurice L. McDaniel—Electrification adviser, Pioneer Cooperative Assn., Ulysses, Kans.

Earl D. Merrill—Director, agricultural extension bureau, Republic Steel Corp., Republic Bldg., Cleveland, Ohio.

L. B. Miller, Jr.—General manager, Miller Bros. (Mail) Box 14, Merritt, N. C.

John H. Moody—2025 Sunset Drive, Ames, Iowa.

John R. Moore—Service dept., Harry Ferguson, Inc., Detroit, Mich. (Mail) Room 311, 2051 W. Grand Blvd.

Frank J. Newcomb—District agricultural engineer, New York State College of Agriculture. (Mail) 309 E. Main St., Endicott, N. Y.

John S. Perry—Instructor in agricultural engineering, Pennsylvania State College, State College, Pa.

A. A. Pfingsten—Rural sales engineer, Wisconsin Public Service Corp., Green Bay, Wis.

R. L. Phillips—Agricultural engineer, Soil Conservation Service, USDA. (Mail) 11 Pearl St., Council Bluffs, Iowa.

Herman S. Poorbaugh—Agricultural consultant, R. H. Sheppard Co., Inc., Hanover, Pa.

James D. Prendergast—Draftsman, Harry Ferguson, Inc. (Mail) 20405 Woodingham Dr., Detroit 21, Mich.

Milton L. Richardson—Multnomah County Production Marketing Administration. (Mail) 4263 S. E. Belmont, Portland, Ore.

E. L. Rietz—Chief development engineer, Lilliston Implement Co., Albany, Ga. (Mail) 414 Oglethorpe Ave., Apt. 3.

(Continued on page 352)

PROFESSIONAL DIRECTORY

Applicants for Membership

(Continued from page 350)

Charles J. Rives—101 N. Michigan St., Roswell, N. M.

Carl L. Sadler, Jr.—Assistant chief engineer, Sundstrand Machine Tool Co., 2531 - 11th St., Rockford, Ill.

William J. Schmid—Teaching assistant in agricultural engineering, University of Idaho, Moscow, Idaho.

John W. Shipp—Assistant engineer, Athens Plow Co., Athens, Tenn. (Mail) 291 Madison Ave.

Torlief Skjerseth—Brocket, N. D.

Ralph G. Spomer—Farmer, Alexander, Kans.

Alfred W. Steinke—Irrigation engineer, Bureau of Reclamation, USDA. (Mail) Jacobson Block, Minot, N. D.

Oscar A. Timm—Clerk, farm implement parts dept., International Harvester Co. (Mail) 80 Ashley St., Hamilton, Ont, Canada.

Victor B. Tkac—Sales engineer, W. R. Ames Co. (Mail) 515 Edinburgh St., San Mateo, Calif.

Lester F. Whitney—Graduate fellow in agricultural engineering, Michigan State College, East Lansing, Mich.

George C. Whorfe—Trainee, International Harvester Co. (Mail) 13 Glenwood Rd., Menands, N. Y.

Clyde L. Wilson—Graduate assistant in drainage work, Ohio State University. (Mail) Box 850, Tiffin State Hospital, Tiffin, Ohio.

John C. Woodruff—Student trainee, J. I. Case Co. (Mail) 360 W. Jefferson St., Syracuse 2, N. Y.

Bernard H. Zellner—2579 Arlington, Memphis, Tenn.

TRANSFER OF GRADE

W. J. Ridout, Jr.—Rural service director, Edison Electric Institute, 420 Lexington Ave., New York 17, N. Y. (Junior Member to Member).

A. Rosen—Director, S. A. Reinforced Concrete Engineers (Pty) Ltd. (Mail) 15 5th Ave., Highlands North, Johannesburg, South Africa. (Associate to Member).

New Federal and State Bulletins

A Modified Wet and Dry-Bulb Thermometer Technique for Determining the Moisture Content or Storage Qualities of So-Called Dry Materials, by S. T. Dexter. Article 31-31, February 1949. Reprinted from Michigan Agricultural Experiment Station (East Lansing) Quarterly Bulletin Vol. 31, No. 3, February 1949. Describes a small sample technique based on the relation between moisture content in the sample and relative humidity of the adjacent air; and on the temperature influence of humidity on various salt solutions used on the wet bulb near the sample in a closed container.

Tractor Plow Adjustment and Operation, by Dale O. Hull. Bulletin P95, Iowa Agricultural Extension Service (November, 1948). This is a 28-page practical guide to reasons for keeping plows in good repair, adaptation of plow bottom materials to soils, plow bottom alignment, hitches, trash-covering attachments, and slot moldboards.

Timber Beams Reinforced with Spiral-Drive Dowels, by G. P. Boomsliter. Research Bulletin No. 23, West Virginia Engineering Experiment Station (Morgantown). Test data on typical beam assemblies.